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INVESTIGATION OF THE EFFECTS OF FOOD STANDARDS ON PESTICIDE USE

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Three commodities, fresh market oranges, processing tomatoes and cling peaches were assessed concerning the role of pest related (largely insect) quality standards and their relationship to pesticide usage.

In each of the commodities cosmetic quality standards appear to have a significant effect on pesticide usage, both in regard to the amount of chemicals used and the utilization of specific pesticides and in regard to the general approach to pest management. In general, extremely strict quality standards seem to mitigate against the adoption of integrated pest management (IPM). Growers are reluctant to adopt such programs because they are forced by processor, marketer and consumer pressures to strive for virtual "zero" pest levels. This is a major reason why available IPM programs which maintain crop quality and yield while reducing pesticide usage up to 50 percent are hardly used by the growers of the three crops assessed in this study.

(Continued on next page)

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There appears to be a clear necessity, then, for appropriate administrative or legislative action which would permit the public agencies whose mandate it is to protect the quality of the environment to intervene aggressively, if necessary, on behalf of those sectors adversely affected by environmental degradation resulting from inadequacies in the economic and administrative systems currently determining pest related quality standards for produce.

EPA Review Notice

This report has been reviewed by the Office of Pesticide Programs of the Environmental Protection Agency and approved for publication. Approval does not signify that the contents necessarily reflect the views and policies of the Environmental Protection Agency or does mention of trade names or commercial products constitute endorsement or recommendation for use.

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SUMMARY

Three commodities, fresh market oranges, processing tomatoes and cling peaches were assessed concerning the role of pest related (largely insect) quality standards and their relationship to pesticide usage.

In each of the commodities cosmetic quality standards appear to have a significant effect on pesticide usage, both in regard to the amount of chemicals used and the utilization of specific pesticides and in regard to the general approach to pest management. In one commodity (processing tomatoes) insect contamination of produce is also a factor. In general, extremely strict quality standards seem to mitigate against the adoption of integrated pest management (IPM) or serve to prevent integrated pest management from being fully utilized. Even where IPM programs are effective under prevailing standards, growers are reluctant to adopt such programs because they are forced by processor, marketer and consumer pressures to strive for virtual "zero" pest levels. This is a major reason why available IPM programs which maintain crop quality and yield while reducing pesticide usage up to 50 percent are hardly used by the growers of the three crops assessed in this study. This is one of the most unfortunate aspects of the prevailing produce standard situation, because IPM programs demonstrably produce efficient pest control at reduced cost and pesticide usage.

While federal and state regulations and consumer preference appear to play some role in the determination of cosmetic standards, more direct economic motivations on the part of growers and processors appear to be of greater importance. Other researchers have commented on the welfare loss due to artifically maintained prices for agricultural resources due

to the functioning of marketing orders and other forms of quality and quanity control. In this report, it is pointed out that further negative social impacts due to pesticide use are also attributable to these mechanisms. Our investigation reveals that while modifications in consumer attitudes and clarification of ambiguous federal and state regulations are desirable, it is unlikely that changes in these areas alone will have a significant effect on produce quality standards and current pesticide use practices. In order for this to happen there must be direct incentives aimed at modifying pesticide use patterns, and a concurrent careful examination of the entire system of production and distribution of specialty crops as it relates to pesticide overuse. This latter undertaking will be particularly difficult because the current system of allocation of resources for specialty crops was not designed to provide a means of economic expression on behalf of the stability of the agro-ecosystem, the health and welfare of farmworkers, the public health, or even the long-term economic well-being of individual growers. The various types of legislation that were passed into law in the depths of the Great Depression were designed to provide the failing small farmer with a modicum of short-term security. It is not surprising, then, that the current system results in negative impacts in areas the importance of which have been recognized only in the very recent past. There appears to be a clear necessity, then, for appropriate administrative or legislative action which would permit the public agencies whose mandate it is to protect the quality of the environment to intervene aggressively, if necessary, on behalf of those sectors adversely affected by environmental degradation resulting from inadequacies in the economic and administrative systems currently determing pest related quality standards for produce.

RECOMMENDATIONS

The following recommendations are suggested as areas in which the EPA may wish to sponsor further work on produce quality standards and pesticide use. While some of the recommendations may appear to be unrelated to produce quality standards or pesticide use, they are designed to have an impact in these areas through the interconnections described in this report.

Pesticide Use

If more and better information were available to growers it is probable that pesticide use decisions in regard to produce quality standards would be more rational from a personal as well as a social standpoint. This does not mitigate the fact, however, that under the most ideal circumstances in regard to information availability, produce quality standards still would remain as an obstacle to the full implementation of integrated pest management. Nevertheless, a need exists for the establishment of more realistic and reliable economic threshold levels for pest damage and pest contamination levels in regard to produce quality, and an efficient mechanism for the communication of this information to the grower. Little research has been done in the area of the relationship between pest damage and cullage due to cosmetic defects, and more is needed. In addition experimentally derived and verified pest damage assessment systems should be made universally available so that growers are able to make pest management decisions on the basis of actual pest population levels rather than prophylactic or pre-programmed treatment. These and other goals would be effectively approached if the quality of pest management advisory personnel were improved. Wayne Willey has evaluated various economic incentives that could be implemented for this purpose. Another approach would be to increase the licensing requirements for pest control advisors. We would suggest the following minimum requirements:

Pest control advisors should not be allowed to be directly or indirectly employed by agricultural chemical companies to function in a sales capacity; that is, the income of pest control advisors should not be related to the amount of pesticides applied. For the same reason, pest control advisors should not be allowed to solicit pesticide application services, or for that matter, be directly involved in sales of biological controls or other non-chemical controls, or to be associated with companies vending particular pest control technologies. To allow such associations is analogous to allowing physicians to have a financial interest in pharmaceutical companies; it does not guarantee that the best mode of therapy will be followed. Alternatively, it is envisaged that contract advisement provided that it is based on a set predetermined fee could involve producers of various types of control agents, in a way that is analogous to the the functioning of a human HMO.

In addition it would be highly desirable for pest control advisors to receive university level education in integrated pest management, plant and animal systems ecology, pesticide toxicology, environmental health, natural resource and agricultural economics, and law and institutions in regard to pesticide regulations, food quality standards, marketing orders, cooperatives, grower-processor contracts, worker health and safety and environmental impact. The basis for such an interdisciplinary curriculum is available at the University of California, and probably elsewhere, but there has been no attempt to design a specific Pest Control Advisor programsof this nature, though the current pest management curricula do contain some of the features indicated here. It would also be desirable for pest control advisors to undergo field internships, preferably under the supervision of experienced integrated pest management consultants. An internship program of this nature supported by a three year grant from the Noyes Foundation, is currently being conducted by the University of California, Berkeley. Reaction by both students and professional pest management participants has been extremely positive. Postgraduate education and periodic retesting of pest control advisors would also be desirable. Finally, the Pest Control Advisor licensing examination should be designed to test the ability of the candidate to deal with complex pest control situations rather than the individual's ability to respond to simple technical items.

The idea of regional pest control districts which would provide integrated pest management advice should also be explored. Such districts might be supported out of state or federal revenues, by a compulsory tax or assessment on growers and/or other sectors of the agricultural system, or by voluntary assessment among grower-members of special cooperatives established for the purpose of pest management.

Pesticide Use Regulation

More stringent pesticide use regulation could serve as an incentive for efficient use of pest management technology and discourage the use of pesticides for non-substantial pest damage. One measure that might help in this area would be to require that the Pest Control Advisor indicate the reasons for recommending the use of a specific pesticide application. The report should ideally contain data of the past and present population levels of the pest, the expected economic damage if treatment is delayed or cancelled, the rationale for the specific material or technique recommended and the alternative measures considered. Such a requirement would tend to discourage unjustifiable pesticide treatments and these reports could also serve as an important data base for the evaluation of pest management practices and the development of an improved pest management strategy. In this connection, it would be of great benefit if intensified and expanded research on integrated pest management were undertaken by federal agencies, the state agricultural experiment stations and perhaps agri-business itself.

It seems reasonable that County Agricultural Commissioners should be responsible for the administration of pesticide use regulations, however, because of their natural tendency to identify with the interests of agriculture, it does not seem proper that they should administer worker health and safety regulations. More appropriate agencies might be the State Departments of Public Health or the Federal Occupational Safety and Health Administration. In addition, in the agricultural area it would seem advisable to give some type of official recognition to farmworker representatives for the purpose of detecting and reporting pesticide poisoning incidents and/or violations of worker safety regulations. In those cases where farmworker unions are recognized, union designated persons might assume this responsibility as is the case with other groups which function under the provisions of OSHA. Farmworkers are certainly in a better position to detect such incidents and violations than the understaffed offices of the County Agricultural Commissioners.

Quality Standards

A systematic study of quality standards for specialty crops is needed to determine the specific degree of cosmetic content crop by crop. A uniform system of quality standards should be developed and there should be a consumer education campaign on the meaning of quality standards in fresh and processed produce. Quality standards should be modified with regard to maximizing the efficiency of pest management technology. The standards should be specified with more regard to end use, so that highly cosmetic quality standards are not used unnecessarily in regard to produce that is allocated to noncosmetic uses. Improved systems of allocation of produce to various grades could facilitate this.

The Federal Food and Drug Administration regulations pertaining to insect contamination should be clarified in regard to the source of the insects, and processors should not be allowed to cite the FDA regulations to justify specific cosmetic standards for fresh produce used as an input to the processing plant. The whole matter of insect contamination levels and the real hazard posed by minuscule insects or insect parts should be brought under intense scrutiny, especially since there is reason to believe that in many cases the hazards posed by insect control far outweigh those posed by the insect contaminants.

The role that cosmetic quality standards may play in facilitating undue market power by growers, processors or retailers should be investigated in regard to possible anti-trust violations. This is especially relevant since the Capper-Volstead Act and the Marketing Order Act forbid the use of marketing cooperative or marketing order mechanisms to obtain undue market power. Incentives to encourage the development of a greater number of diverse marketing cooperatives and firms which could offer a range of quality of produce to the market should be explored. At present most specialty crops are dominated by a single marketing organization which may not be able to serve the diverse needs of all the growers in the industry. In this connection, California is currently experimenting with a state operated direct marketing system for fresh produce. Marketing order boards should be modified so that representatives from a wider diversity of interest are included. Marketing order boards in California now must have some consumer representatives and this is a step in the right direction. Such representation would help insure that quality standards are designed to fulfill the needs of groups other than growers and processors.

The potential for absorption of surplus produce through secondary markets should be explored. Potentials include allocation of produce that doesn't meet the cosmetic quality standards of the primary market but is otherwise fully wholesome and nutritious to such segregated and guaranteed markets as federal school lunch programs or other food programs for families below a certain income level. Such programs should not damage the aggregate demand for produce of high cosmetic quality since the bulk of this demand comes from high income families. Another variant of this approach is to sell surplus produce from the processing sector on a field--run basis directly to the consumer, at minimum state quality standards. This has been done on a limited basis in California since 1975 by the Consumer's Cooperative of Northern California, and consumer response has been highly favorable. This latter approach, of course, could result in a reduction in demand for some high cosmetic quality produce.

Tax shelter and subsidy programs which have resulted in false market signals and misallocation of agricultural resources should be examined and modified. Possible regional or state systems of agricultural resource allocation which might result in more rational long-term planning in agricultural production should be explored.

Consumer Attitudes

The determinants of consumer behavior in regard to the consumption patterns of fresh and processed produce should be investigated. Consumers should be fully informed on the nature of insect contamination in fresh and processed produce and on the use of pesticides in food production. Consumers should be educated concerning the manifold consequences of cosmetic food production.

INTRODUCTION

> It shall be the object and duty of the State Agricultural Experiment Stations through the expenditure of the appropriations hereinafter authorized to conduct original and other researches, investigations, and experiments bearing directly on and contributing to the establishment and maintenance of a permanent and effective agricultural industry of the United States, including researches basic to the problem of agriculture in its broadest aspects, and such investigations as have for their purpose the development and improvement of the rural home and rural life and the maximum contribution by agriculture to the welfare of the consumer, as may be deemed advisable, having due regard to the varying conditions and needs of the respective States.
>
> --Hatch Act, 1887

Agricultural research, as defined by the Hatch Act, is based upon a pluralistic ideal, taking the welfare of all sectors of society into account. However, some persons question how well agricultural research, in reality, has maintained the ideal of the Hatch Act. Agricultural Economist Alex F. McCalla has written,

> What has happened in the twentieth century is that the Land Grant establishment has redefined its mission to be primarily production agricultural efficiency rather than the much broader charge contained in the Hatch Act. Thus, rather than perceiving the general public, particularly those that are "disadvantaged", as our clientele we have given special attention to production agriculture....
> While doing this we have identified very closely with our perceived clientele so that often, after a couple of generations, we begin to think like them, share their values, and come to perceive their sanction of our activities as necessary and desirable....
> Issues of environmental quality, consumer safety, nutrition, quality of rural life, and many others have arisen in part, in the public's mind, because of our single purposed dedication to production efficiency....It is time we focused our goals to serve our many publics, including, but not limited to, agribusiness.[1]

In this report we have attempted to keep in mind the original intent of the Hatch Act. While pesticide use has had an undeniable positive effect on the capability of production agriculture, pesticide use has also produced some negative externalities, externalities which often occur in subtle and indirect ways and which impact on groups and individuals who may not receive any direct benefit form this aspect of agricultural technology.

The purpose of this report is to investigate the relationship between cosmetic food quality standards and pesticide use, and to detect any elements of the current system of laws, regulations and practices which result in negative impacts to public health and environmetnal quality. The relationship between quality standards and pesticide use is not simple and direct. It is conditioned by political, economic, legal, technical and ecological factors that, together, constitute the environment in which modern agricultural production operates. In this report we have attempted to describe these relevant factors and their impact on the issues under consideration.

In Chapter 1. the origin, history and current nature of the relevant quality standards is examined and the meaning of a "cosmetic quality standard" is defined.

In Chapter 2. pesticide use, regulation and impact is examined, especially in regard to California. The alternative available approaches to pest management are examined and the factors which influence pesticide use decisions are described.

A brief outline of the impact of pesticides on man and the environment is also presented.

In Chapter 3. the complex relationship between cosmetic quality standards and pesticide use is closely examined in California oranges with emphasis on fruit produced for the fresh market.

Chapter 4 briefly treats of our investigation of produce quality standards as they affect pesticide usage in processing tomatoes and cling peaches.

Sources of information for this report include the technical literature in the fields of agricultural economics, pesticide and quality standard law, applied entomology, pesticide toxicology, epidemiology and other fields. We were privileged to obtain information from a number of studies in progress or not yet published. In addition personal communications with academic researchers; county, state and federal officials; individuals associated with grower organizations, processing firms, shipper and packer organizations, retail food chains; farmworker union representatives, and private pest management consultants were carried out. It was anticipated that systematic interviews with a large number of growers, farmworkers, consumers and other relevant groups would be carried out. However, efforts in this direction were frustrated by the Federal Office of Management and Budget which refused to approve the appropriate survey questionnaire even after all technical and administrative objections had been properly responded to. To our knowledge, the requested survey was never actually formally turned down and we were never notified of the reason for the survey not receiving approval. The lack of this important research tool was made up for, in some instances, by the coincidence of other survey studies which partially met the needs of this report. However, the inability to conduct survey studies in important areas of concern did restrict the study to primarily qualitative rather than quantitative conclusions. Nevertheless it is hoped that the tendencies identified will prove to be a useful guide in the consideration of pesticide policy.

This report represents the first attempt to study a subject that is complex and broad. The report, then, is primarily descriptive. However, because this report defines and characterizes a new area of concern it can serve as a guide to additional, more specialized and systematic investigations. Some specific areas for additional study are identified in our recommendations. Finally, for various reasons this study primarily concerns insecticides. However, it should be clear from what we report that this discussion has broad implications for pesticide usage.

Footnote

1. Alex F. McCalla, Public Sector Research and Education and the Agribusiness Complex: Unholy Alliance or Socially Beneficial Partnership?" American Journal of Agricultural Economics, December, 1973, p. 1001.

CHAPTER 1. QUALITY STANDARDS FOR FRESH AND PROCESSED PRODUCE IN CALIFORNIA

The establishment and administration of quality standards for fresh and processed produce in California is not the exclusive domain of any single agency. To understand the nature of food quality standards a complex system of private and public institutions at the county, state and federal levels must be examined. The relevant institutions for fresh produce quality standards include the California State Legislature, the California Department of Food and Agriculture, state and federal marketing order boards, agricultural marketing cooperatives, shipper and packer organizations, retail food distributors and the consuming public. In regard to processed produce the roles of the Federal Food and Drug Administration and food processing companies and cooperatives must also be considered.

The cosmetic aspect of food quality standards has not been formally defined within any of these institutional structures. Thus, a definition of "cosmetic quality standard" will be constructed and the degree to which various institutions contribute to the cosmetic aspect of food quality standards will be considered.

PRODUCE QUALITY STANDARDS

The two categories of quality standards that are relevant to this study are those which pertain to the marketing of fresh produce and those which pertain to produce which is sold as an input to processing firms. In both cases formal, statutory standards exist; however, for many crops the operationally effective standards are those that are required by contractual agreement between producers and buyers, or by the joint agreement of producers through marketing cooperatives and marketing orders. In most cases this latter type of quality standard is much more stringent than the statutory standard.

QUALITY STANDARDS FOR FRESH PRODUCE

The establishment and enforcement of quality standards for fresh produce is essentially a state function. The federal government does maintain a system of federal grades as a service to buyers and sellers. According to the National Commission on Food Marketing, "One of the principle functions of Federal grades for fresh fruits and vegetables is to provide a basis for describing products and, thereby, facilitate trade between shipping point and terminal market firms."[1] The National Commission goes on to document the fact that federal grades do, in fact, play a substantial role in commerce between the sellers and buyers of fresh fruits and vegetables.[2] Nevertheless, federal grades are not the same thing as mandatory quality standards.

The purpose of federal grades is to provide buyers and sellers with a common basis of information. Grades are not directly linked to mechanisms that function to allocate produce between the primary and secondary markets or to withhold produce from the market. Thus, to the extent that grades represent accurate and accessable information, they may serve to increase producer and consumer welfare. Quality standards may be directly linked with mechanisms which serve to constrain the amount of produce that may reach the primary market in a given period. In this sense, quality standards may place constraints on the functioning of consumer sovereignty. Quality standards may also result in other externalities, such as are the subject of this report.

The Federal Food, Drug, and Cosmetics Act specifically forbids federal quality standards, providing that "no standard of quality shall be established for fresh or dried fruits, (or) fresh or dried vegetables."[3]

California State Quality Standards

The California legislation regulating the quality of fresh fruits and vegetables began to develop early in this century.[4] Because of progress in transportation, eastern markets were beginning to be accessible to fresh California produce. Thousands of small growers and shippers scrambled to serve these markets. It was in the interests of each grower to reach the market first each season to reap the premium prices available for early produce; invariably the competition resulted in many shipments of insufficiently ripe produce. Further, the hope of growers to sell all their crop led to the swamping of the markets in peak season with produce of marginal quality. Deceptive packaging, marking, and grading were used to hide defective produce. Eastern wholesalers, retailers, and consumers became cautious about California produce and prices began to fluctuate. To protect consumers by eliminating deceptive practices and thus to promote the reputation and the business of the state's agricultural industry, both inside and outside the state, the California legislature established minimum maturity, size, packing, and labeling standards for some of the major California fruits and vegetables.[5]

The quality standardization laws have grown progressively more comprehensive and complex. They now apply to the sale or shipment of all fresh fruits and vegetables, packed or in bulk.[6]

The state of California has enacted quality standards with respect to pest damage which apply, across the board, to all fruits and vegetables.

These criteria are rather broad and vague, providing that any fresh fruits or vegetables cannot be sold unless 90 percent by weight, of the produce, is free of worms, mold, decay, or any insect injury which has penetrated the edible portion, as determined by inspection of representative samples.[7]

Crops to which additional, specific quality standards apply are apples, apricots, artichokes, asparagus, avocados, berries, broccoli, brussel sprouts, cantaloupes, carrots, cauliflower, celery, cherries, citrus fruit, corn, dates, grapes and raisins, lettuce, melons, nectarines, onions, peaches, pears, peas, persimmons, plums and fresh prunes, pomegranets, potatoes, quinces, sweet potatoes, tomatoes and walnuts.[8]
State quality criteria for selected crops are shown in Table 1.

In the past California state quality standards for fruits and vegetables were established as statutes by the California legislature. Beginning in 1975 this authority was transferred to the Director of Food and Agriculture. Under the current law the Director, upon a petition from a commercial grower or handler, "may", and upon a petition from 10 commercial growers or handlers "shall" hold a hearing to establish, modify or rescind a quality standard for a fruit, nut or vegetable product. The Director's decision must be based upon the following criteria:

1. The regulation will provide the consumer with acceptable quality fruits, nuts, and vegetables which will also provide stability in the marketing of such products.

2. The regulation will tend to prevent waste in the production and marketing of fruits, nuts, and vegetables.

3. The Director will consider the impact of the regulation upon the agricultural industry.

All quality standards enacted by the state legislature before 1975 are carried over into the new system as regulations unless the Director finds them to be unsatisfactory.[9]

While it is difficult to evaluate quality standards except on a crop-by-crop basis, it is safe to say that the Califronia state quality standards for fresh fruits and vegetables are, by and large, directed at maintaining a minimum level of produce quality and are concerned primarily with maturity and substantial damage. One reason the standards have been set low in the past is that, as the statutes required legislative action for adoption or amendment, they could not be readily altered in response to emergency situations, such as an abrupt change in the weather, that might suddenly result in a substantial reduction in the quality of a specific crop, though the crop might still be basically wholesome.[10]

Growers apparently have no great difficulty in meeting the current standards as evidenced by the fact that for the fiscal year 1972-73, 99.6 percent of the produce inspected in Fresno County was passed. (Fresno County is the largest agricultural producer of any county in the United States, measured by the gross value of sales. The value of its crops in 1972 were in excess of $550,000,000.[11]

There has been some pressure to increase the level of the state quality standards. For example, the Western Growers Association, which is a major shipping organization for California row crops, has consistently lobbied for increased quality standards. According to a Western Growers Association spokesman, the effect of increased quality standards is to improve the quality reputation of California produce and to improve the competitive position of fresh produce relative to processed produce.[12]

MARKETING ORDERS

Under the provisions of federal and state marketing orders, producers may agree to establish and enforce quality standards in addition to those specified by state law. In 1968 there were 49 marketing orders in effect under the federal provision and 34 under the state of California.[13] Of the 91 federal and state marketing orders tabulated by the National Commission on Food Marketing, 76 percent contained provisions for grade, size, maturity, or other quality control.[14] The general goal of marketing orders is to increase the net return to the grower by improving market organization, by increasing consumer demand, by regulating the flow of the produce to the market place, and, in some cases, by restricting the total supply of the product. The quality standards that are specified by marketing orders are tied to this general goal and related to one or more of these mechanisms.[15,16]

MARKETING COOPERATIVES

Under the provisions of the Capper-Volstead Act the producers of a commodity may join together in a cooperative for the purpose of jointly marketing their produce.[17] Marketing cooperatives may establish and enforce their own quality standards. For example, Sunkist Growers, Inc., the major marketing cooperative for fresh California oranges maintains a set of quality standards that is far more comprehensive, specific and stringent than the regular state quality standards.[18]

PRIVATE MARKETING ORGANIZATIONS

Likewise private marketing organizations may maintain their own set of quality standards. For example Kenneth Dunham of the giant produce marketing firm Heggeblade-Marguleas-Tenneco testified in 1973 that, "we have consistently strived with the growers to upgrade the quality of their produce in order to compete in the marketplace, domestic and international. We are relentlessly hammering at the growers to put up the finest package of fruit and vegetable possible. If you ask why we have done this over the years and are continuing to do so, it is done for the growers' salvation--not to become fat with profit, but to enable them to compete in the marketplace with their products, whether it is fruit, nuts or vegetables, with a reasonable return to invest."[19]

RETAIL STANDARDS

The most comprehensive use of quality standards in fresh produce occurs in the buying transactions of large supermarket chains and in the selling of produce to these chains by large marketing organizations. Buyers for retail supermarkets have reported to us that cosmetic criteria are routinely used in selecting produce. The buyers state that the standards they use are not written down or codified in any way, but that they are acquired from a buyer's experience regarding what consumers will or will not buy.

Crates or boxes of produce in which insects are found are often rejected summarily. Buyers maintain that the presence of one insect often indicates that more may be present in the shipment. It makes no difference whether the insect is one which attacks the commodity on which it is found or whether it is an innocuous insect that does not feed on the commodity. Evidence of insect damage is treated almost as seriously as the presence of insects. Buyers said that produce must be practically free of insect damage to be saleable.

Size and color are also cosmetic criteria that are important to buyers. Retail stores often like to stock two sizes of the commodities for which there is a federal grading system (e.g. apples, oranges, tomatoes, etc.)

Retail store buyers prefer to buy the largest produce within a given grade. They have commented that consumers are often uninformed as to what size indicates; smaller produce within a grade may have better taste qualities according to the buyers but consumers seem to always equate maturity and quality with size. Color is important for the same reasons; consumers equate good color with maturity and quality. According to the buyers, this is not always true. The cosmetic criteria applied are flexible and vary with the season and with the availability of produce. Buyers are constantly in touch by phone and by personal visits with wholesale brokers and with large growers who sell directly to retailers. They actively compare the produce which is available and buying decisions are made by balancing price with cosmetic quality, assuming that the produce is acceptable on other grounds.[20]

Don Dressler of the Western Growers Association concurred with this viewpoint. He asserted that the use of agricultural chemicals was vital in obtaining produce with the "right color" and for "blemish control". He thought that the cosmetic appearance of fresh produce was a major factor in competition against canned and frozen produce which have the advantage of picturesque labels and elaborate packaging. According to Dressler, "fresh produce is its own label". Dressler also contended that even a small proportion of non-cosmetic produce appearing in the marketplace could spoil the consumer market for the entire industry. He was especially upset about the marketing of "organic crap".[21]

Not all produce people feel this way. According to Bill Ramsey, supervisor for Mann Packing Company, which ships 25 percent of the nation's broccoli, it is the retail buyers, not the consuming public, who demand the maintenance of high cosmetic quality standards. According to Ramsey, a reduction in the cosmetic quality standards would result in a saving to both the grower, who would use less pesticides, and the consumer. "Consumers buy the relative best so if quality goes down, they would buy the relative best," said Ramsey.[22]

According to the Sunkist Newsletter of August, 1976, regreened oranges, Valencia oranges that have turned green when left on the tree beyond the point of early ripening, are "sweet and juicy", as good or better than orange colored fruits. However, the Sunkist Newsletter of September, 1976, reports that, "Regreening continues to be a serious problem this season and is proving to be a major factor contributing to heavier amounts of non-premium fruit".

Barney McClure of the Botsford-Ketchum advertising agency has designed campaigns to educate consumers to the non-cosmetic aspects of fresh produce. "One winter (artichoke growers) had a heavy frost which turned the outside leaves of the chokes brown. They put on a campaign which explained that frost-kissed artichokes really have improved flavor. They turned frost damage into a money-maker." According to McClure, "Some of the new peach varieties have been developed with an eye toward blush, that beautiful color that is associated with peaches. But there is a problem with them. They don't taste so good. I think people are ready for a change. This growing emphasis on consumerism is beginning to counter 40 years of effort and promotion of the perfect produce."[23]

This "consumerist" attitude was expressed by Christina Rose, of the California Department of Consumer Affairs, who testified in 1973, that,

> In spite of the original purpose of commodity standards, there are those who question whether their real benefit accrues to the consumer in every instance.
>
> They ask, for example, if consumers might not gladly purchase fruit and vegetables for cooking purposes which did not meet the stringent standards to which they have become accustomed, but which could be purchased at a reduced price consistent with greater supply.
>
> The price of a food product is, in some measure, influenced by the quality and maturity standards applied to basic agricultural commodities. To increase the price, one may raise the standard acceptable on a given commodity and thus reduce the legal supply available on the market.
>
> A substantial lowering of the standard will increase the supply and may reduce the price, but will possibly provide to the consumer what would previously have been considered an inferior product.[24]

COSMETIC QUALITY STANDARDS

Nowhere in the vast system of quality standards for fresh produce is there a definition of a "cosmetic" quality standard. However, commentators within and outside of the fresh produce system have acknowledged the existence of such a thing for many years. At this point, based upon our review of quality standards for fresh produce, it seems clear that a cosmetic quality standard can be defined in the following manner: A cosmetic quality standard is one that refers to superficial damage to or alteration of the exterior appearance of the commodity; damage or alteration which does not significantly affect the taste, nutrition or storage capacity of the produce. Of course, this report is concerned, more specifically, with cosmetic damage that is actually caused by, or is attributed to, insect or other pests.

From our review of quality standards for fresh produce we can make the following comments regarding the relative degree to which quality standards incorporate a cosmetic component. The regular state quality standards refer, by and large, to minimal maturity and non-cosmetic quality criteria. The quality standards that are established and enforced by marketing cooperatives and marketing orders often contain substantial cosmetic components. Finally, at the retail level, cosmetic factors seem to play the decisive role in decisions of the large marketing concerns to buy or not to buy fresh produce. According to retail store buyers this reflects a "cosmetic consciousness" on behalf of the consumer.

QUALITY STANDARDS FOR PROCESSED FOODS

PROCESSED FOODS--STATE STANDARDS

The states play little part in setting quality standards for processed foods. The first attempts to regulate processed foods were made by the states, but the emergence of a national economy and the dominant proportion of processed food shipped through interstate commerce made national regulation necessary. State power to regulate products in interstate commerce was limited. Conflicting regulations made it difficult for producers to serve multi-state markets. The Federal Food, Drug and Cosmetic Act now is the dominant force in regulating processed foods.

California's health codes illustrate the merger of state and federal regulations. Claifornia does have one state stuatute which controls the quality of food which can be processed, but the standards are totally non-cosmetic.[25] But beyond this statute California has adopted the federal standards.

PROCESSED FOODS—FEDERAL STANDARDS

The primary federal statute which regulates, inter alia, the quality of processed food is the Federal Food, Drug, and Cosmetic Act (FDCA).[26]

The main purpose of the Act is to protect consumers from the dangers of unwholesome food. In general, FDCA provides for the promulgation of three types of food standards which an interstate processor must meet.[27] The three types of standards are identity, quality, and fill of container. The Act prohibits from interstate commerce, foods which are "adulterated" or "misbranded,"[28] and the receipt or delivery of such defective foods. Almost all the civil and criminal violations with respect to food under FDCA involved adulterated or misbranded food, both of which are given broad definitions. The Food and Drug Administration, (FDA), under the Department of Health, Education, and Welfare, is responsible for administering the major part of FDCA.

Section 402 of FDCA[29] gives the Secretary of HEW the authority, delegable to FDA, to "promulgate regulations fixing and establishing for any food, . . . a reasonable definition and standard of identity, a reasonable standard of quality, and/or reasonable standard of fill of container" excepting most fresh fruits and vegetables. FDA has issued a large number of regulations under the authority of section 402 covering nearly all processed food. Most of these regulations are concerned with mandatory standards of identity and fill of container to insure that consumers receive what they reasonably expect they are buying.[30]

FDA has also issued standards of quality for the major processed foods, but very little of the standards' contents are concerned with quality that could be termed cosmetic. The general exception is the requirement that most processed fruits cannot contain more than a stated percentage of fruit (usually between 15 and 20 percent) blemished with "scab, hail injury, scar tissue or other abnormality or discoloration." But none of the quality standards are mandatory; the processor may market his product without penalty if only it is labeled as being below the FDA standards. The objective is disclosure to the consumer as to what he is buying, giving him the opportunity to make decisions on quality without setting governmental quality standards which are mandatory. Hence, the FDA has chosen not to use the authority delegated by section 402 to set minimum quality standards.

Rather, the FDA regulates the quality of processed foods by promulgating regulations and tolerances which, in part, define adulteration as the failure to meet certain quality standards. Because FDCA prohibits the introduction or delivery for introduction into interstate commerce, or the receipt in interstate commerce, of adulterated food,[31] it then becomes a crime to use interstate commerce to sell processed foods which do not meet these quality standards.

Section 402(a)(3) states that a food is adulterated if "it consists in whole or in part of any filthy, putrid, or decomposed substance, or if it is otherwise unfit for food." The FDA and the courts have applied this section in such a manner as to define and enforce standards to include insect debris which in fact, poses no threat to human health whatsoever.[32]

If section 402(a)(3) were strictly construed and enforced, it would ban all processed food from interstate commerce. Even with the best of technology all defects in food cannot be eliminated. Technologists using only a microscope can find at least minute quantities of decomposed or moldy substances in almost all processed food. These minute amounts make the food "in part" filthy and hence adulterated, even though they pose no possible danger to human health.[33]

Further, the courts have uniformly held that 402(a)(3) is to be interpreted in the disjunctive,[34] that the phrase "otherwise unfit for food" does not limit the phrase which bans food in whole or in part which is filthy, putrid, or decomposed. Thus food containing minute amounts of "filth" could be found to be in violation of 402(a)(3) even though it is fit for food, and indeed, even if it is of excellent quality. This interpretation reads the word "otherwise" out of the statute.[35] But the courts have accepted this interpretation, rationalizing that Congress may have wanted to set a standard well above what was required for the health of consumers. A high standard would force the industry to inspect strictly, thus reducing the probability that dangerous food might reach the public even very infrequently.

Thus the dilemma arises that, despite the clearly undesirable result, the Act if strictly enforced would conceivably ban from interstate commerce essentially all processed foods. Section 306 of the Act allows FDA the discretion not to prosecute minor violations,[36] but this only begs the question as to when to prosecute because there is no guidance in the Act as to what constitutes "minor" adulteration since all food is to some degree adulterated.

To reasonably limit the application of the Act, FDA has established what are called "defect action levels for natural or unavoidable defects in food for humans that present no helath hazard".[37] These are amounts of defects or filth which are allowed in some categories of food because such amounts are often unavoidable. They are established at levels that present no health hazard to humans. They do not represent an average level of defects in processed foods, but are higher than actual empirical averages of such defects. Many of the defect levels are tolerances as to the amount of insect debris allowed in food, and as insect debris poses no threat to human health, these defect levels are minimum quality standards which are accommodated in our definition of cosmetic quality standards. If a product, assuming the processor employs good manufacturing practices, is within the tolerances set by the defect levels, the FDA will not take legal action against it.[38]

In order to explore the FDA's contention that defect action levels apply to damage or debris that does not constitute a human hazard a review of the literature on the human health hazards of ingested insects has been conducted.

From man's antiquity insects and other small invertebrates have been consumed either intentionally as a food source, or unintentionally, hidden from view, in the fruits, seeds and other foods gathered as nutrients.

The range of insects consumed as food is extensive and includes species from all major orders including such loathsome forms, by Western standards, as the head louse. The major criteria in the use of insects and related invertebrates as a food source appear primarily related to their abundance and the ease of capture and/or the large size of such individual insects as aquatic beetles and bugs. Thus even rather small insects that occur in great numbers in time and place such as the ephedrid flies of brine lakes were harvested in great numbers by North American Indian tribes, as were locusts.[39,40] Bodenheimer has extensively reviewed the use of insects as food by peoples of the world and points out that in some human populations insects constitute a substantial source of nourishment. The natives of tropical Africa have used termites extensively as food and these dried or fried insects can be found in the markets for sale. The desert locust is another insect prized as a food in Africa and can be found for sale in markets (e.g., Morocco).

Bodenheimer points out that insects were particularly important to human populations where large-animal protein was scarce and that these insects formed a valuable addition of protein and fat as well as certain minerals, vitamins and salts.

Certain insects do serve as intermediate hosts of various parasites which, when consumed with the insects may continue to develop in humans. For example, the spiny headed worms, Acanthocephala, utilize as intermediate hosts various beetles and other insect species. On rare occasions these worms have been reported as parasites in humans. Certain tapeworms of dogs and rodents which utilize fleas and other insects as intermediate hosts have been reported in man, particularly in children. H. nana which is capable of undergoing autoinfection in humans and is a normal parasite of rodents may be transmitted on occasion to humans by grain beetles Tribolium spp. which serve as excellent intermediate hosts in the laboratory. Contact between rodents infected with tapeworms and grain or grain products infested with the beetles would be the potential route of infection.[41] Treatment for these tapeworm infections is relatively safe and constitutes no serious threat to health. Additionally, cooking of the insects, which often takes place in processing, would eliminate the threat of transmission. Ron Taylor, a forensic toxicologist, has studied the use of insects as food for several years. Taylor found that some people chronically exposed to cockroaches develop allergies. However, Taylor found no evidence of any allergies to insect parts in processed food, nor has he found any toxins in insects that would present a health hazard to humans.[42]

Thus, while some insects and associated debris could be a health hazard to humans under certain conditions, there is no evidence to suggest that herbivorous insects found in food that has been processed present a health hazard to humans.

While extraneous inclusions in food which are within the defect action levels are not hazardous to humans, health hazard is not a criterion[43] used in establishing these defect levels. Instead, the levels are based upon the processing industry's technological ability to remove, through whatever means, the inclusion (defects). The levels are subject to change as technology or new information develops.[44] The FDA states that the defect levels have been and will continue to be reduced and that the food industry has a continuing responsibility to minimize even innocuous defects in food.[45]

The courts have accepted the defect levels as having the force of law. FDCA does not provide authority for FDA to set administrative tolerances for filth, and one court, although basing its decision on an FDA defect level, questioned the scope of the validity of the defect levels.[46] But a substantial majority of the courts accept the defect levels as dispositive.[47] The courts recognize that they do not have the expertise to know what standard of food quality is necessary for the public health nor what performance can be expected from the processing industry.[48] As a minimum, recent decisions show that courts accept the defect levels but imply that they are not bound by them.[49]

The FDA has not adopted defect levels for many processed foods. When a processed food which is under prosecution as adulterated does not have an action defect level, the courts interpret the words "filth, purtid, or decomposed substance" in their ordinary rather than any scientific meaning.[50] The courts have emphasized that the sensibilities and esthetic feelings of consumers are protected by the Act.[51] Without defect levels to guide them, courts often look to expert witnesses to inform them as to what levels of defects are "usual" or "unavoidable."[52] If the contamination is "unavoidable," courts are likely to label the defect as de minimis, below the concern of the law, and find no adulteration.[53] This approach implicitly adopts the same criteria the FDA used to establish its defect levels.

But being beyond the narrow objection of de minimis, insect fragments in other than infinitesimal amount are "filth"[54] even without a danger to health. This would be particularly true for any visible insect fragments. Nearly all the FDA defect levels are set at amounts of filth indiscernible to the human eye, and to our knowledge, there exist no cases that hold that processed food with visible insect debris is not adulterated regardless of whether it is in a category to which a defect level has been assigned. Hence by recognizing consumer sensibilities and by adopting a meaning of filth which does not include any element of potential human harm, courts have interpreted FDCA as including cosmetic quality standards with respect to insect debris.

There are circumstances under which food which is within the defect action levels would still be in violation of FDCA. Section 402(a)(4) states that a product is adulterated "if it has been prepared, packed, or held under insanitary conditions whereby it may have become contaminated with filth, or whereby it may have been rendered injurious to health."[55]

To constitute a violation under 402(a)(4), the court in Berger v. United States[56] held that it is sufficient that the manufacturing conditions "would with reasonable possibility result in contamination."[57] A "mere possibility" of contamination is not enough, but it is certainly not necessary that the food actually be contaminated. The focus of section 402(a)(4) is on the conditions of manufacturers; the objective is to prevent adulterated food by condemning the conditions under which it could be produced.

In 1969 the FDA promulgated regulations applicable to the entire food industry, called good manufacturing practice (GMP) regulations.[58] FDA's objective was to provide detailed standards as to what is and what is not a violation of section 402(a)(4). The regulations specify proper practices relating to plant construction and design, the surrounding grounds, the equipment and utensils, sanitary facilities and their control, maintenance, animal and vermin control, raw material handling, packaging, and personnel work procedures. The FDA intended that the GMP regulations have the force of law and that a violation of one of them would be a violation of section 402(a)(4). Immediately after they were issued, industry lawyers scrambled to argue that the FDA had no authority to endow the regulations with legislative status. They maintained that the regulations could at most be guidelines for the industry which were not binding on the courts.[59]

The FDA has made it clear that violations of the GMP regulations will bring prosecution and the FDA has a high percentage of convictions under section 402(a)(4).[60] But the courts response to the GMP regulations has not been clear. Courts have acknowledged the existence of the GMP regulations, but have grumbled that they are generally inadequate because they are too vague.[61] Generally courts have not mentioned the regulations in their opinions, but have continued to apply the Berger "reasonable possibility" test.[62]

While the FDA recognizes that defect action levels do not refer to contaminants that are hazardous to human health and are not reliable indices of processing plant sanitation, it is FDA policy to "periodically lower (defect action levels) as technology improves". On the other hand this statement is balanced with the FDA declaration that,

> The alternative to establishing natural defect levels in some foods would be to insist on increased utilization of chemical substances... (and)...the very real danger of exposing consumers to potential hazards from residues of these chemicals, as opposed to the aesthetically unpleasant, but harmless natural and unavoidable defects.[63]

Pimentel, et al., have shown that for broccoli and spinach, defect action levels for insect debris has become more stringent over the years. Between 1938 and 1973 the defect action level for aphids, thrips and/or mites in broccoli was 80 per 100 grams. Currently the defect action level is 60 per 100 per 100 grams. In the 1930's the defect action level for aphids in spinach was 110 aphids per 100 grams. Currently the defect action level is 50 per 100 grams. The defect action level for leaf miners in spinach was 40 per 100 grams in the 1930's. Currently it is 8 per 100 grams. Pimentel et al. report that one of the effects of tightening up the defect action level for leaf miners in spinach has been the increased use of insecticides. They conclude that,

> Evidence has been presented that suggests that FDA's ad hoc policy of reducing tolerances in food for small insects that offer no known threat to public health contributes to increasing health hazards from pesticides, reducing environmental quality, using more energy for pest control, and increasing the economic cost of food. Therefore, reducing tolerances for small herbivorous insects in foods to improve the "cosmetic appearance" of the food appears not to be in the best interest of society and this nation.[64]

Contractual Standards

The FDA regulations may be used to justify quality standards that are written into contracts. For example, according to Stanley D. Ray, Agricultural Commissioner for the California County of Stanislaus, where food processing is a major industry,

"The contracting system between growers and processors does have some effect on pest contamination and the related use of pesticides. The requirements, however, are dictacted by strict Pure Food and Drug and USDA regulations, and growers and processors cannot afford to have their commodities condemned because of insect contamination."[65] Additionally James Bell, Executive Vice-President of the Canners' League of California, an organization which represents many marketing cooperatives and small independent canneries, told us that contamination by field insects and insect damage was a major problem for canners because of "consumer standards and behavior and FDA standards."[66]

There is no way in which the FDA regulations can be easily translated into insect-related quality standards for the grower, especially since all insects must be considered potential contaminants whether defect action levels for them have been promulgated or not. Nor are just the fresh produce standards followed in the case of produce that is used as an input for processing. The most important quality standards are those that are specified in contractual agreements between processors and growers. The quality standards for insect and insect damage specified in such contracts are usually much more stringent than state quality standards for fresh produce.

A 1971 contract form from the Canners League of California for tomatoes specifies that the buyer may reject the entire shipment if more than 1/2 percent of the tomatoes contain any worm or worm damage that penetrates the flesh of the tomato. A Hunt-Wesson Foods, Inc. tomato contract specifies that the buyer may reject the entire shipment if any worms or worm damage or insect infestation is present in the flesh, core or stem cavity of any tomato. A Canners League contract for peaches says that the buyer may require peaches to be free of worms, worm damage, parasite or insect damage, and San Jose scale and may reject the entire shipment if there are more than one percent wormy or worm damaged peaches.

Stokely-Van Camp, Inc. which contracts for frozen vegetables specifically requires that produce, be delivered, "in the condition buyer may require, in order to meet the tolerances permitted by and requirements of the United States Food and Drug Administration and in all respects conforming to any applicable Pure Food & Drug requirements of the state or political subdivision thereof in which this contract is to be performed and the crop is to be processed". From this passage one might get the impression that FDA places specific quality requirements on produce at the point of delivery to the processor, which is not the case. It can only refer to the exceedingly vague requirement that input produce from the grower does not contain a level of insect contamination which would result in the processed output exceeding the FDA defect action level for insect debris.

A 1974 Stokely-Van Camp contract for frozen spinach contains the additional, appended provision that, "Any lot of spinach infested with insects including worms or aphids or seriously damaged by any of the above defects (which includes insect damage effecting an area of one square inch on leaf or stem) beyond the level normally accepted in the frozen spinach industry, may be rejected by Buyer."[67]

These stringent contractual standards for insect debris and insect damage may be justifiable, after the fact, on the basis of FDA regulations, but there is no reason to believe that these standards are primarily motivated, in the first place, by the FDA regulations. The FDA regulations are based upon "good industry practice" not vice versa.

CONSUMER ATTITUDES

The other major reason given by industry spokesmen for the tough insect quality standards, is consumer attitudes. It is asserted that consumers demand cosmetically perfect produce and would not stand for processed produce which showed signs of insect damage or contained insects or insect parts. There is undoubtedly a large measure of truth to this assertion, although systematic studies of consumer attitudes toward insect contamination are non-existent. Additionally, it should be noted that many of the insects which are so strictly controlled by the contractual standards would not be detectable in many forms of processed food even if they were present at levels far in excess of current contractual levels, except, of course, by careful microscopic examination.

It should also be asked to what extent current attitudes of consumers are endogenous to human nature and to what extent they are the result of promotional activities by the food industry itself. The United States

Department of Agriculture estimates that in fiscal year 1962 1,200 agricultural groups in the United States spent a total of $86 million to promote agricultural products.[68] Among all California marketing orders advertising and promotion costs averaged about 69 percent of total expenditures in the decade 1960-70.[69] John A. Jamison notes that, "Growers have generally been very optimistic about advertising and promotion throughout the post-World War II history of marketing orders. Demand expansion programs have seldom been met by the vocal opposition that has accompanied quantity control programs. The very fact that the results of these promotional efforts can seldom be measured seems to encourage rather than discourage their use. ...the great faith of producers in such programs seems to be based principally on two premises: (1) that these efforts must be beneficial because advertising is so widely practiced and supported in the case of product advertising vs. brand-name advertising. Furthermore, the effect of this promotional atmosphere may be to raise the overall quality expectations of the consumer for all produce.

Consumer attitudes toward insects in food may also be related to more basic cultural values. In a review of "entomophobia", the irrational fear of insects, Helga and William Olkowski comment,

> A review of the literature on entomophobia and personal discussions with a phychiatrist have confirmed our impression that the basic syndrome is one of fear of contamination, penetration, and/or filth. We find people who take a 'disinfectant' or sanitizing approach to gardening. In some cases it seems to be the germ theory gone astray....This general attitude may be extended to life generally, the natural world is feared, it is repulsive, dirty.... These attitudes are not at all helped by government regulations that refer to insect parts as filth, lumping them together with rodent droppings, the inference being that any insect part is evil whether from beneficial or pest species.[71]

Of course, less acute aversion to insects may be thought of as part of the accepted cultural norm. However, to the extent that consumer aversion to insects is based upon irrational fear or ignorance, it can be countered by informational and educational programs. An intrinsic aspect of such programs should be not just how insect-related quality standards affect consumers directly, but how they affect other segments of the society and social welfare in general.

QUALITY STANDARDS AND SUPPLY CONTROL

There are other possible reasons for the maintenance of extremely stringent contractual quality standards, as well as fresh produce standards, besides consumer attitudes. The contracts are written in such a way that the quality standards can be used as a mechanism for regulating the flow of the supply of raw produce to the processing plant. In periods of short supply quality standards may be relaxed, or below quality produce may be accepted with a penalty loss to the grower. In periods of peak supply, below quality shipments may simply be rejected.

In tesitmony before Senator Gaylord Nelson's U.S. Senate Subcommittee on Small Business hearings on "Corporate Giantism and Food Prices" in 1973, Ruben Reyes, of the Cannery Workers Organizing Committee, stated,

> I know that when I worked as a weightmaster for the Libby, McNeill and Libby people for ten years, I know that the grading procedures that they used are not overseen by the state or any regulatory agency. In other words, the plant, itself, pruchases the product and they do whatever they want in regards to grading it and paying the farmer.
>
> I know that for the ten years that I was a weightmaster, the company I worked for was ripping off the farmers for at least $50,000--$60,000 a year in their deliveries on spinach, altering the grades, and by altering the grade of spinach they were purchasing. I have written evidence by some of the company employees that were doing the purchasing...they were ripping off the farmer.

> The quality control that the companies all have are under their control. In other words, there is no outside agency to oversee the quality control work done by the companies themselves. They grade the product, they buy the product, they grade it to whatever category they want to and they sell it. It can be the worst product in the world but they can sell it as prime stock because there is nobody there to stop them.[72]

It is not strictly true that there are no outside agencies to oversee quality control, state inspection on the input side and FDA regulations on the output side set lower bounds for quality. But, Reyes' remarks suggest that between these lower bounds and the upper bounds set by contract provisions, processors may exercise discretion in adjusting the enforcement level of quality standards to meet their economic requirements.

In Table 1 we have summarized the quality standards for several commodities that prevail under the various systems we have described. It can be seen that the quality standards specified by private marketing organizations tend to be more stringent, more specific and more comprehensive than those promulgated by public agencies.

As indicated, quality standards of all kinds are written by and primarily in the interest of producers, processors, and retailers. The preferences of the consumer may be given recognition but, in fact, consumers have had little to say about the development of the current system of quality standards. However, even less consideration has been given to the possible consequences of quality standards on the welfare of agricultural workers, the stability of the agro-ecosystem and the general environment, or the long-term economic and physical health of the public. While the current system of quality standards may benefit some groups, they may actually be a detriment to other groups that have had no influence in devising the system.

As the late Senator Philip Hart observed, "You can make certain book that consumers will elect to have unblemished fruit unless and until they become aware that the price of unblemished fruit is dead farm workers."[73]

COSMETIC QUALITY STANDARDS SUMMARY

As we stated earlier (pg. 11), it would seem reasonable to define a "cosmetic" quality standard, as "one that refers to superficial damage to or alteration of the exterior appearance of the commodity; damage or alteration which does not significantly affect the taste, nutrition or storage capacity of the produce". The state quality standards for fresh produce do not seem to be, primarily cosmetic standards. Rather they set minimum levels for maturity of produce and prevent misrepresentation in packaging and labeling. However, the actual effective quality standards, which are established and enforced by marketing organizations, with input from retail sellers, often contain considerable and significant cosmetic quality aspects.

In the case of processed produce, the quality standards that are established by processing firms and enforced through contractual agreements with growers often contain cosmetic quality aspects, especially in regard to insect parts, which are sometimes justified by referring to Federal Food and Drug regulations.

The additional proviso should be made, that damage due to insects or other arthropod pests or their effect on produce appearance can only be considered cosmetic if the specific pest does not in some other way significantly disrupt the production system for the crop.

15. Alison Masson, "The Economic Effects of Marketing Orders", in *Report on Agricultural Cooperatives*, Bureau of Competition, Federal Trade Commission, Washington, D. C., 1975.

16. J. P. Doll, V. J. Rhodes and J. G. West, *Economics of Agricultural Production, Markets, and Policy*, Richard D. Irwin, Inc., Homewood, Illinois, 1968, pp. 491-513.

17. U. S. Congress, House Committee on the Judiciary, Subcommittee on Monopolies and Commercial Law, Hearings, *Food Price Investigation*, 93rd Congress, 1st Session, June, July, 1973, Serial No. 15, p. 711-715.

18. "Rules and Regulations Governing Fruit Packed for Marketing by Sunkist Growers, Inc. Under its Trademark Sunkist, Excel, SK, and Red Ball and Under Association Non-advertised Brands," Sunkist Growers, Inc. November 1, 1967.

19. Fond, *op*. *cit*., December 4, 1973, p. 80.

20. Tsueio Koto, Assistant Produce Buyer, Co-op, Pers. Comm., Richmond, California, March 14, 1975.

21. Dressler, *op*. *cit*.

22. Bill Ramsey, August, 1974, Salinas, California.

23. Evan Maxwell, "Perfect Produce: Cosmetic Defects Hold Key to Profits," *Los Angeles Times*, August 20, 1971.

24. California Legislature, Assembly Select Committee on Agirculture, Food and Nutrition, March Fong, Chairman, Interim Hearing, *The Shipping Point Inspection System*, December 3, 1973, Riverside, California, p. 70.

25. Cal. Food and Agric. Code p. 41361 (West 1968)

26. 21 USC pp. 301-392.

27. 21 USC p. 341.

28. 21 USC p. 331.

29. 21 USC p. 341.

30. Sec. 21 CFR pp. 10-125.

31. 21 USC pp. 341, 342.

32. 21 USC p. 342 (a) (3).

33. *Ibid*.

34. *U.S. v. 1,500 Cases More or Less, etc*., 236 F2d 208 (7th Cir. 1956).

35. See Circuit Judge French's dissention *U.S. v. 449 Cases, Etc*., 212 F2d 567, at 575 (2nd Cir. 1954).

36. 21 USC p. 336.

37. Anonymous, *Current Levels for Natural or Unavoidable Defects in Food for Human Use that Present no Health Hazard*, HFF 342, HEW-9NS-FDA, Wash., D.C. 1976.

38. 21 C.F.R. p. 128.10.

39. C. T. Brues, *Insect Dietary*, 1942 Cambridge, England, pp. 419-422.

40. E. O. Essig, "The Value of Insects to the California Indians, " *Science Monthly* 38(2): 181-186. 1934.

41. C. J. Weinmann, personal communication, Department of Entomological Sciences, University of California, Berkeley.

42. Ron Raylor, pers. comm., September 23, 1974, Los Angeles, California.

43. Alex McCormick, pers. comm., Compliance Offices, FDA, in San Francisco, pers. comm., July 31, 1974.

44. 21 C.F.R. p. 128.10 (c).

45. 38 Fed. Reg. 854 (1973).

46. U.S. v. 449 Cases, etc., 212 F2d 567 (2nd Cir. 1954).

47. *U.S. v. 1500 cases, More or Less, etc*., 236 F2d 208 (7th Cir. 1956).

48. Ibid., at 211.

49. *U.S. v. 484 Bags, More or Less*, 423 (F2d 839 (5th Cir. 1970; *U.S. v. 1,200 Cans, Pastuerized Whole Eggs*, etc., 338 F. Supp. 131 (N.D. Ga. 1972).

50. *U.S. v. Roma Macaroni Factory*, 75 F. Supp. 1663 (N.D. Cal. 1947.

51. *U.S. v. 1,500 Cases More or Less, etc*., 236 (F2d 208 (7th Cir. 1956); *U.S. v. 935 Cases of Tomato Puree*, 65 F. Supp. 503 (N.D. Ohio, 1956.

52. *U.S. v. 1,500 Cases More or Less, etc*., 236 F2d 208, 212 (7th Cir. 1956).

53. *U.S. v. Capital City Foods, Inc*., 345 F. Supp. 27 (N.D. 1972).

54. *U.S. v. Cassaro, Inc*.,443 F2d 153 (1st Cir. 1971).

55. 21. U.S.C. p. 342 (a) (4).

56. 200 F2d 818, (8th Cir. 1952).

57. *Ibid*. at 821.

58. 21 C.F.R. p. 128.

59. Cody, Authoritative Effect of F.D.A. Regulations 24 (F.A.C.L.J. 195 1969).

60. Alex McCormick, pers. comm., see footnote #16.

61. *U.S. v. 1,200 Cases, Pasteurized Whole Eggs, etc*., 339 F. Supp. 131, 141 (N.D. Ga. 1972).

62. See *U.S. v. H. B. Gregory Co*., 502 F2d (7th Cir. 1974); *U.S. v. Cassaro, Inc*., 443 (F2d 153 (1st Cir. 1971).

63. Anonymous, *Current Levels for Natural or Unavoidable Defects in Food for Human use that Present no Health Hazard*, HFF 342, HEW-PHS-FDA, Washington, D. C., 1976.

64. D. Pimentel, *et al*., "Pesticides, Insects in Foods, and Cosmetic Standards," *Bioscience*, in press.

65. Stanley, D. Ray, pers. comm., August 6, 1974.

66. James Bell, pers. comm., August 16, 1974. Sacramento, California.

67. See Appendix A for copies of contracts.

68. Godwin, *op. cit*., p. 359.

69. Jamison, *op. cit*., p. 307.

70. *Ibid*.

71. Helga and William Olkowski, "Entomophobia in the Urban Ecosystem, Some Observations and Suggestions," paper presented to American Institute of Biological Sciences, Tempe, Arizona, June, 1974.

72. R. Reyes, statement before U. S. Senate Subcommittee on Small Business, Hearings on "Corporate Giantism and Food Prices," 1973, reported in *The AgBiz Tiller*, September, 1976.

73. Statement of Agribusiness Accountability Project on Occupational Safety and Health Act of 1970 before U. S. Department of Labor Hearings, August 23, 1973.

CHAPTER 2. PESTICIDE USE AND REGULATION IN CALIFORNIA

In considering the relationship between produce quality standards and pesticide use it will be helpful to divide pesticide use into two broad, but distinctive categories, rather than a large number of arbitrary ones. Then rather than attempting an evaluation of the impact of cosmetic quality standards on the use of hundreds of materials it will be necessary only to evaluate the effect of these standards on the general approach to pest control. This approach is not only convenient, it is also appropriate because, in fact, two competing concepts of pest control exist and the ability of the grower to adopt one or the other concept in his overall approach may be significantly influenced by the existence of cosmetic quality standards. These two general concepts of pesticide use will be described, and current status of the two in California will be evaluated. Additionally, the effect of federal and state pesticide use regulations on grower pesticide use decisions will be examined.

PESTICIDE USE AND REGULATION IN CALIFORNIA

It is important and useful to examine pesticide use and regulation in California for several reasons. More pesticides are used for agricultural purposes in California than in any other state in the nation. In 1973, 183,657,000 pounds of pesticides were sprayed on 26,618,000 acres of California farm land.[1] Partly because of this high use, California was one of the first states to develop a system of pesticide use regulation and it currently has the most highly developed regulatory system in the country. In fact, the California system has been looked upon as a model for the development of a Federal system of pesticide use regulation.[2] For this reason, it is important to critically examine the California system. Additionally, California is the leading state in the production of "specialty" crops in which cosmetic quality standards may play an important role and in which a substantial amount of pesticide use may be attributable to "cosmetic" pests. California is the leading producer of almonds, apricots, artichokes, broccoli, grapes, lemons (second in oranges), lettuce, nectarines, peaches, pears, strawberries and tomatoes, all crops in which cosmetic quality plays an important role.[3] Nationwide, fruits and vegetable crops account for 21 percent of agricultural insecticide use. Many of these crops account for a greater usage of pesticides than would be expected on the basis of their acreage. For example, apples, which account for 0.07 percent of total crop acreage, account for 6 percent of all agricultural insecticide use. Citrus, which accounts for 0.08 percent of total crop acreage, accounts for 2 percent of all agricultural insecticide use.[4]

In California, where most of the nation's specialty crops are grown, these crops account for a very significant proportion of pesticide use, as Table 2 demonstrates.[5]

Thus, while the use of pesticides attributable to the need to meet cosmetic quality standards cannot be said to be the bulk of agricultural use, it may be significant enough to have important consequences for public health and the stability of the ecosystem, especially as an accumulative process. Furthermore, the average figures tend to obscure the fact that pesticide use attributable to cosmetic quality standards may be relatively highly concentrated, in localized growing regions. Thus, the agricultural counties of Fresno, Imperial, Kern, Merced, Monterey, San Joaquin, Tulare and Ventura which comprise only about 20 percent of the area of

California, accounted for over 60 percent of all pesticide use in that state in 1974.[6,7]

PEST MANAGEMENT TECHNOLOGY

Pesticide use decisions related to cosmetic quality standards are partially dependent on the pest management technology which is available and, just as important, is acceptable to the user. Current pest management technology can be characterized by two basic, and sometimes conflicting, concepts. These characterizations are general, and are not meant to describe the specific pest management practice of individual advisors, which consists of the whole spectrum of possible practical approaches encompassed by these idealized concepts. The first concept, "conventional chemical control," has grown with the production and use of agricultural chemicals and has become a major approach to pest management, especially in the last two decades.

This approach is centered around what is felt to be the pragmatic use of agricultural chemicals for the suppression of specific insect pest populations. This often includes the use of chemicals in a preventive or prophylactic manner and the use of pesticides which have a broad-spectrum of activity, including toxicity to beneficial insects, and other non-target species and humans. The efficacy of conventional chemical control has as a total strategy been seriously questioned in recent years by some entomologists. For example, C. B. Huffaker and Ray F. Smith of the Department of Entomological Sciences of the University of California, Berkeley, have written that:

> There was (in conventional chemical control) a general disregard of the fact that even the simplest agricultural system presents a maze of delicately balanced ecological intricacies. Elaborate calender treatment schedules were developed on a prophylactic basis. Both approaches not only ignore the complexity of agroecosystems, but both of them ignored the two giants of nature's own system of pest control, i.e., over-the-eons-evolved plant resistance and control by natural enemies.

> Since the single objective of the unilateral broad-spectrum chemical approach was total and lasting destruction of the pests, serious disturbances soon arose. Target species counterattacked, developing resistance to one material after another. Adverse effects on natural enemies and stimulating effects on some pests have released the target species to rapid resurgence and caused minor or innocuous ones to become serious pests. Increasing dosages, and more kinds of, and more frequent, chemical applications have led to pesticide addiction from which it is difficult to withdraw. Problems of residues and adverse environmental effects at places even far removed from treated areas have led to public clamor against all pesticides.
>
> We do not believe that our insect problems would simply disappear if we would stop using insecticides but we do not believe the consequences would be quite as intense, ubiquitous or prolonged as some would have us believe. Yet, this public clamor, indeed, threatens to deny the research needed to assure availability of *proper* chemicals to save our crops when needed and, as well, to perpetuate an enlightened, lasting control program.
>
> The unilateral chemical approach has not even had the prolonged success in the control of the initial insect targets that was first suggested. Insect problems have not lessened; they are even greater than before. We are using more chemicals and against more species of insects than ever before. Some agricultural enterprises are threatened with disaster from mounting pest control costs, yet poor pest control.[8]

Table 3 tabulates the most important insect and insect-like pest species in California and the degree to which they have developed resistance to insecticides and are involved in resurgence or secondary outbreak problems. The table gives stunning insight into the breakdown of the chemical control strategy in California, an area of advanced agro-technology.

The alternative concept that Huffaker and Smith, and others, have proposed is *integrated pest management* or *integrated control*. Integrated pest management strategies attempt to take into account all the relevant factors that impinge upon the agroecosystem. For example, Pimentel lists: pesticides, non-target species, pathogens, insects, weeds, pollinators, human health, biocontrol agents, rotations, soil preparations, fertilizer, diversity, water, plant density, sanitation and plant genetics as relevant factors. According to Pimentel, "the total costs, benefits, and risks of the factors in the system can be evaluated and used as a basis for making sound decisions about pest control measures." Pimentel concludes that, in general, pesticide use in the United States could be significantly reduced if,

1. Bioenvironmental pest controls which were placed with pesticides were again put into full practice wherever possible.
2. Some or all of the 60 million acres currently diverted at a cost of $3 to $4 billion annually were planted to help balance the increased crop loss resulting from a reduction in pesticide use. (In recent years this has been done.)
3. A "treat-when-necessary" program based on monitoring pest populations was initiated and aircraft spray drift was reduced.
4. The public were educated to be concerned for the safety of their fruits, vegetables, and other produce and attach less importance to "cosmetic appearance."[9]

While a specific pest may be suppressed by a number of alternative means, such as chemical control, biological control or cultural control, integrated pest management is an overall strategy for maintaining the health and productivity of the agro-ecosystem. Integrated pest management includes the option not to control for a pest when it is determined that the costs outweigh the benefits. As Luck, van den Bosch and Garcia have recently commented:

> This (integrated pest management) represents a change in the philosophy of pest control: it utilizes and builds upon the natural mortality that affects any pest population, it tolerates uneconomic densities of pests and it aguments natural control with a variety of techniqeus that are tailored to be minimally disruptive. . . . Thus, there are various techniques and materials that can be utilized in pest management systems in which knowledge of the species and their ecosystems permit the integration of natural and artificial mortality factors in mutually augmentative

> programs. These can lead to maximum pest control efficiency with miminum ecological impact . . . . Under this concept chemical control reverts from its present role of a single strategy to that of a mere tactic. Confusion of the latter with the former is a basic reason for much of our current pest control dilemma.[10]

The philosophy of integrated pest management, when carried to its logical conclusion, implies that, in addition to the immediate welfare of the grower, the welfare of other groups in society should be considered in pest management decisions. However, it is unlikely that this will be the case when the pest control advisor is employed directly by, and in the interests of the grower. As was stated at the 1973 IBP Integrated Pest Management Conference on Economic Injury Evaluations:

> There is often a conflict between farmers and the rest of society. Farmers on one hand make decisions which directly affect production costs or yields and thus influence profits whereas society may consider a pesticide free environment to be more important than pest control in an individual field, farm or area. Therefore, we must consider who benefits from Pest Management Programs; both farmers and society should benefit from these programs if they are to be truly successful.
>
> The costsof using pesticides may be greater than the benefits which we usually associate with increased yield or better quality because of externalities. For example, in many of our cost/benefit calculations we exclude damage to the environment, the hazards in using pesticides etc., and base our calculations of benefits only on increased yield or quality.[11]

Feder and Regev have considered the case in which agricultural pests are conceptualized as a common property resource and biological interactions and environmental effects are taken into account. When this kind of a situation is mathematically modeled and the pest control decision expected from a single grower is compared to the decision that would be made as the result of a social optimization rule, the following results are obtained:

> The stock externalities inherent in the decentralized solution lead to myopic decision rules that are not optimal from society's viewpoint. An additional external effect for some pesticides is pollution of the environment by pesticide residue. A centralized control solution incorporates the population dynamics and environmental effects. The optimal decision rule then equates marginal benefits with monetary marginal cost of control plus the user cost. The three elements comprising the user cost involve the effect of the marginal unit of control on the stocks of pest, predator and residue.[12]

This is not to say that pest control must be conducted by a central authority, only that it would be preferable to employ incentives or regulation so that the sum of individual grower pest control decisions would approach the socially optimal decision.

While the integrated pest management approach, even when applied for the direct benefit of a client grower, takes more of the total social welfare into account than the conventional chemical control approach, there is still plenty of room for conflicting goals. An economic threshold level of population which is determined on the basis of meeting a cosmetic quality standard for the benefit of the grower may be socially inappropriate if, in addition, the welfare of the farm worker or the long-term stability of the agro-ecosystem is not taken into account. Just how such factors are to be accommodated is a political and economic problem.

SOURCES OF PEST MANAGEMENT INFORMATION

The particular approach to pest management that growers adopt depends on the availability and the effectiveness of various pest management information sources. Von Rumker has studied this problem in relation to corn and soybean growers in Iowa and Illinois. It is clear from the von Rumker study that the conventional chemical control approach dominates in Iowa and Illinois corn and soybean farming. According to von Rumker:

> A substantial portion of the corn soil insecticide uses appear unnecessary or wasteful, while most growers consider their individual decisions to use a preventive treatment a necessary protection against possible yield losses.[13]

On sources of pest management information von Rumker comments:

> There are currently no effective, unbiased channels through which growers could receive such information regularly and in a timely fashion from the public agency originators of the information.[14]

The available information indicates that the situation in California with regard to pest management information is similar to Illinois and Iowa. However, there are some notable differences. In California integrated pest management information is available not just from some public sources but it is also available from some private independent pest management consultants. Most of these private consultants, who have no ties to chemical companies and sell their professional advice rather than chemicals, are members of the Association of Applied Insect Ecologists (AAIE), a professional society which explicitly endorses integrated pest management. The AAIE defines Integrated Pest Management as "The modern concept of careful monitoring of crops for insect populations, recognition of economic damage thresholds and avoidance of pesticide applications on simply a preventative schedule. IPM includes environmental and cultural management, biological control as well as the careful use of pesticides." AAIE's professional and general membership numbers about 100.[15] This can be compared to the force of state licensed pest control advisors employed directly by private agricultural chemical companies in California. To determine this Dr. Christine Merritt, a Staff Research Associate in the Department of Entomological Sciences, University of California, Berkeley, has polled the 133 California agricultural chemical firms listed in the directory of the Western Agricultural Chemical Association. Ninety-five of the firms responded to the poll: 89 percent of the firms employed agricultural pest control advisors; the total number of the advisors employed by the firms was 1648. This was a slight underestimation because one of the largest agricultural chemical companies did not specify the number of advisors it employs. If the average 17.35 advisors per firm is projected to all 133 firms the number of advisors would be about 2300. Thus, in the private sector the number of pest control advisors that would tend to favor the conventional chemical control concept far out-numbers those who endorse integrated pest management. In fact the top five agricultural chemical firms alone employ in excess of 550 advisors, more than five times the membership of AAIE. The bulk of California's pest control advisors are in the direct employ of private agricultural chemical companies and they far out-number the combined advisors, private and public, that are available in California to provide independent pest management advice.[16]

Gutierrez and Loew have polled 1200 California cotton growers on their preferred source of pest management information. Of the 415 growers who responded, 66 percent listed chemical company representatives as the preferred source, 13 percent listed independent pest management consultants, and 17 percent listed themselves. Fifty-seven percent of the growers reported using a prophylactic miticide, a strong indication of a conventional chemical control approach. Gutierrez and Loew could detect no correlation between the grower's decision to use integrated pest management and grower experience or size.[17] The 13 percent figure for the use of independent pest management consultants may be atypical because integrated pest management has made more head-way into cotton than any other crop in California.

Based on an intensive survey of pest control practices in cotton, alfalfa hay, processing tomatoes, and grapes in Calfiornia, Wayne Willey determined that, in 1972, 8.7 percent of these crops, by acreage, were under independent pest management. It was also determined that with sugar beets, nuts, deciduous fruits, vegetables, melons, and alfalfa seed, 6.7 percent of the crops were under independent pest management. The total revenue of the independent pest management consulting industry in 1972 was $3 million. This compares to a total pest control industry revenue of $600 million.[18]

Data from a survey of the California citrus industry indicates that about 6 percent of California orange growers utilized independent pest managers in 1972.[19]

In evaluating the factors which determine growers' decision to adopt, or not to adopt, integrated pest management, Willey observes that:

> Several consultants indicated that they would not seek to expand the acreage served until they become certain that existing clients are satisfied. The implication is that the growers must develop enough confidence in the consultant so that an occasional less than satisfactory performance will be overlooked. Such poor performance will inevitably happen to even the best consultant due to the complexity of the agroecosystem that he attempts to control. The crux of the problem vis-a-vis the grower's confidence is that when poor performance occurs, the tendency is to place the blame on the consultant's low pesticide use at certain times when pest populations are present. However, the fact often is that a heavier use of pesticides would not have provided economically viable control. Subject to massive pesticide advertisement via the media and salesmanship centered around an exploitation of the grower's ever present fear of losses, the tendency among growers to single out the consultant's low pesticide use persists. Instances in which pesticide salesmen have approached growers immediately after a consultant has indicated that a pesticide treatment should not be undertaken have occurred. The salesman's strategy in those cases was to "fear talk" the grower into a lack of confidence in the consultant's judgement. Such fear is easy to exploit when a pest is present and can be visually identified for the grower by the salesman. Thus, the uncertainty to the consultant which accompanies his attempt to gain the confidence of a sufficient number of clients is a key factor in the availability of information services.[20]

It should be added that the existence of stringent cosmetic or pest contaminant quality standards can only magnify the "fear factor" whether it originates in the promotional activities of the pesticide salesman or the mind of the grower. In this regard, we know of at least two reported cases where growers deliberately sprayed beneficial insects because they were afraid of having marketing organizations find insect "contamination" in their fields. In one case a Syrphid fly larva (an aphid predator) was interpreted as a looper infestation by a lettuce packer, resulting in rejection of the crop; in another case a tomato grower sprayed his crop because of an "infestation" of lady beetles.[21]

REGULATION OF PESTICIDE USE IN CALIFORNIA

California has a well developed system of pesticide use regulation. Pesticide dealers, pest control operators, and pest control advisors are licensed by the State Department of Food and Agriculture. Pesticide use permits must be obtained by operators and users in the case of restricted substances from County Agricultural Commissioners and pesticide use reports must be filed with the County Commissioners. The County Commissioners are also responsible for enforcing pesticide use regulations, including the State farm worker safety regulations which preempt those promulgated by the Environmental Protection Agency.[22]

California provisions for the protection of farm worker health are more comprehensive than the federal EPA provisions which apply to most states in which state provisions do not exist.

According to Greenstone,[23] the California provisions, which are promulgated by the California Department of Health, are similar to the kind of provisions non-agricultural workers enjoy under the federal Occupational Safety and Health

Act (OSHA). Greenstone considers the exemption of agricultural workers from OSHA unjustifiable discrimination against farm workers. According to Greenstone:

> The Environmental Protection Agency has not, by its promulgation of pesticide reentry regulations similar in form to those originally and tentatively formulated by OSHA, actually exercised authority over agricultural working conditions, because its standards envision workers as only one element in an ecological balancing process. . . . EPA can give worker protection no greater weight; protection of the work force is defined as incidental to a consideration of the environment as a whole. . . . No language mandating a balance of economic, social, and ecological benefits can replace the assurance of a workers' bill of rights. Worker health and safety and the legislation which guarantees it may not be compromised, as OSHA early recognized.[24]

ENFORCEMENT

While the California farm worker safety provisions come closer to the OSHA ideal than federal EPA provisions, several observers have expressed reservations about the efficacy of enforcement by California County Agricultural Commissioners.

Dunning, as well as others, is concerned about the political origin of County Agricultural Commissioners, noting that they are "hired and fired by the county board of supervisors, which in rural counties generally is dominated by local growers." The Commissioners see themselves as politically neutral. In response to a recently proposed bill which would have required the election of County Agricultural Commissioners "to assure agricultural workers are given as much attention as the growers," the California Agricultural Commissioners Association stated that the commissioners "are the least politically-oriented group of any, and if we had to start playing politics our office simply would not function as well."[25]

Dunning also noted that when pest control operators violate regulations, sanctions are weak. A criminal sanction exists, but it is rarely used. Even when it is sought by commissioners, district attorneys throughout California have been reluctant to comply.[26] Dunning noted the use in Imperial County of mass appeals by the Agricultural Commissioner:

> For example, pest control operators have been asked to avoid spraying fields with workers in them; to take precautions against the drift of sulphur, an irritant to the eyes, onto residential properties; and to avoid applications which do not conform to the product's registration, unless special authorization is obtained. All the acts cautioned against are unlawful, and the warnings suggest that the Agricultural Commissioner's office has had reason to believe they were taking place with some frequency. A general warning may be helpful in curbing such violations, but the use of this technique also seems to reflect the present lack of any 'middle level' sanction for violations by pest control operators.[27]

Howitt[28] reports the following information on the level of enforcement activities of all County Commissioners in California:

Fiscal Year	District Attorney Hearings	Court Citations Issued	License Suspensions
1969-70	2	3	56
1970-71	6	3	70
1971-72	-	2	70
1972-73	-	23	117

This level of enforcement activity is in reference to several thousand pest control advisors and applicators. Chronic and acute pesticide poisoning remains a substantial problem for California's farmworkers and others associated with pesticide usage at this current level of enforcement.

Dunning also found the job permit system, upon which compliance with pesticide use regulations is based, to be cumbersome and inadequate. According to Dunning:

> With the manpower available, this is inevitable, for the quantity of applications forbids meaningful individual review within the time available. Furthermore, there is insufficient information upon which to base a decision. Permit applications presently show only the pesticide(s), location of the area to be treated, grower's name and address, total acres to be treated, commodity, pest(s), type of material (dust, spray, or other) and method of application. This enables one to determine some basics on label compliance, but little else. If pesticide use were limited to "need," for example, and if the permit system were to be locked

> to for enforcement of that concept, then the regulatory officials engaged in review of permit applications would have to have far more information in order to make intelligent decisions. In fact, given the complexity of pest control, it would probably be necessary for an official to visit the field to be treated under the permit for which application is made. Ultimately the most serious contemporary need in pesticide use is sound judgement exercised by decision makers with ecological awareness, and this need will not be met simply by insistence upon filling out and review of forms.[29]

Indeed, Agricultural Commissioners report that they needed more manpower for field inspection, and that they do not have adequate resources to enforce worker safety regulations.[30]

LICENSING PROCEDURES

Imperial County pioneered all licensing of pest control advisers. Pest control advisers are required to register, pass a qualifying examination and pay a license fee. It might be thought that the examination requirement would improve the quality of pest control advice available to growers but, according to Dunning, "the examination specified refers to knowledge of pesticides, not pest control . . . ." No one in Imperial County who had been engaged in the pesticide business has been excluded as a result of the examination.[31]

Since the Dunning study, the examination requirement for pest control advisers has become a state-wide requirement. Barry Wilk, who has a Masters Degree in entomology and has worked as a graduate Research Assistant and Staff Research Associate in entomology for five years, took and passed the state examination in 1975. Wilk felt that anybody who carefully read the study guides provided by the state could pass the examination and that passage of the examination would not qualify the individual to be a competent pest control advisor. Wilk spoke to another person taking the exam who stated that he had taken a course at Modesto Junior College in which he had been drilled in many questions which were identical or similar to those which appeared on the examination. Additionally, a grower friend who had previously worked for a major agricultural chemical company in Los Angeles, offered Wilk a large stack of past exam questions when Wilk informed him that he intended to take the examination. Wilk said that his impression was that these questions were available to the employees of agricultural chemical companies who were preparing to take the examination.[32] Ironically, during the course of our investigation, we were refused copies of past examinations by CDF&A officers on the grounds that the validity of the examination depended on this security measure.[33]

Wilk proposed that a more valid certification procedure would require a series of courses in pest management, similar to certain pest management courses taught at the University of California, supervised field experience, and an examination which required the individual to explain how he would deal with specific pest management situations and scientific justification for the proposed course of action.

Everett Dietrick, a commercial insectary owner and licensed pest control advisor, told us that his secretary (clerk, typist, receptionist) with no prior pest management training, acting on a dare, studied for the pest contrc advisor's examination, passed it and is now a licensed advisor. It would seem, from what has just been described, that the examining and licensing standards for California pest control advisors hardly rank with those required in high quality professions. Dunning[34] proposes that the up-grading of pest control advisor quality could be approached by the simple measure of making it illegal for any licensed pest control advisor to be an employee of, or have financial interest in any agricultural chemical company, or any company which has a financial interest in any pest control technology.[35]

STATE ACTION

Dunning found basic failures at the state level in taking the initiative on pesticide policy. In 1971 the State's Director of Agriculture determined that integrated control would be officially supported as the best method for dealing with agricultural pest problems, but Dunning notes that little has been done to implement this decision.[36]

According to Dunning the Department of Food and Agriculture has also failed to follow through on state legislation, enacted in 1969, which required the development of "an orderly program for the continuous evaluation of all economic poisons (pesticides) actually registered" in order to "endeavor to eliminate from use in the state any economic poison which endangers the agricultural or nonagricultural environment, if not beneficial for the purposes for which it is sold, or is misrepresented." The Department of Agriculture has stated that it simply did not have the resources to carry out such an ambitious program.[37] However, the Department has been criticized by the State's Legislative Analyst for wasting its resources:

> One reason the registration workload is not handled on a timely basis is because the registration staff spends a large portion of its time correcting errors in the applications for registration or requesting copies of the proposed label. This time-consuming and expensive practice of correcting errors should be curtailed. It is the responsibility of the registrant prior to submitting the application to assure that it is correct. The Department now permits itself to be used as a service arm of the industry which it is to regulate. Much of the time which should be spent implementing new statutory policies is diverted to performing a service for the most inefficient registrants of economic poisons.[38]

THE IMPACT OF PESTICIDE USE IN CALIFORNIA

The ultimate purpose of this study and the reason for preparing this report has been to ascertain, if possible, whether statuatory or privately imposed produce quality standards increase the hazard posed by pesticides (insecticides in particular) to human health and the environment. To do this we chose California as our laboratory because it was convenient to us, it has a great diversity of crops which enter the specialty fresh produce or processing markets, it has pioneered through legislation and private action the imposition of cosmetic and pest contamination standards, and it is the nation's most intensive pesticide user.

Pesticides are hazardous: for example the modern synthetic insecticides are overwhelmingly either nerve poisons or cholinesterase inhibitors which affect exposed insects and humans in exactly the same ways. In addition, some of these insecticides are actual or suspected carcinogens, teratogens and mutagens. The other classes of pesticides such as the herbicides, fungicides and rodenticides also include materials which are hazardous to human health and to the environment.

There is a considerable literature on the impact of pesticides on wildlife and other lower life forms ranging from fish, birds and mammals to honey bees.[39,40,41] Suffice it to say, this impact is often severe. On the other hand there is a paucity of organized information on the effect of these materials on the food chains and food webs in our agroecosystems in which arthropods play a fundamental role. This in unfortunate because much of the ecological backlash, and hence the resultant treadmill effect of pesticide usage in crops (and other resources too), results from the disruption of insect communities by insecticides and other pesticides (e.g., fungicides).

As for human health impacts, there is no existing systematic review of evidence concerning the effects of pesticide use on the health status of farmers, farmworkers, pesticide applicators or the general public, either for California or the nation as a whole. However, the official report of more than 1300 human pesticide poisonings in California in 1975[42] indicates that adverse effects of pesticides on human health is a serious and continuing environmental problem deriving from crop protection. Indeed, if we accept the public pronouncements of Dr. Ephraim Kahn, Chief, Epidemiological Studies Laboratory, California Department of Health, that the reported poisonings only represent about 1% of the actual cases of pesticide caused intoxication,[43] the list of "official" poisonings is but the tiny tip of a disturbingly large toxic iceberg. Dr. Kahn not only supports his contention, with data developed by himself, but he is further backed by a 1969 study by the California Department of Health[44] which revealed that fewer than 1% of farmworkers with pesticide-caused illnesses serious enough to require treatment reported their illnesses via the worker's compensation channel. And, this is the channel through which statistics are largely obtained to compile the "official" annual reports of illnesses.

A later study by Richard Howitt of the Department of Agricultural Economics, University of California, Davis reported a lower discrepancy between actual pesticide-caused illnesses and those reported through workmen's compensation. In this early assessment of his data Howitt indicated that roughly half as many illnesses were reported as actually occurred.[45] However in recent testimony before a hearing of the California Senate Committee on Health and Welfare, Howitt indicated that only about

5 percent of the illnesses are reported.[46] The findings of Kahn and Howitt are highly disturbing for they clearly indicate that there is a very high risk of illness from occupational exposure to organophosphate and other pesticides. In fact, comparing the number of working hours lost to pesticide illness per 1,000 man hours (5.25 hrs/1000 man hrs.) with that in the other most hazardous occupation in California, the construction industry (4.9 hrs lost to illness and injury/1000 man hours),[47] the farmworker appears to have one of the most, if not the most, dangerous occupations in California.

There is also evidence of widespread occurrence of chronic, low grade (virtually symptomless) intoxication among farmworkers (and by inference others in the general populace, too) which certainly magnifies the pesticide poisoning problem.

A statement by Dr. Thomas Milby points up the nature of the chronic toxicity problem. Milby states: "our research leads us to suspect, furthermore, that there is probably an even more common form of adverse effect, one which is even slower to develop and even subtler in its manifestations. The individual may not feel nauseated, dizzy, etc., he may not lose any time from work at all, but he may have a little more difficulty getting to sleep at night. His appetite may be a little less hearty than it was. And there may be a gradual impairment of his hand-eye coordination and other neuromuscular functions, so that he is able to pick 10% fewer oranges or peaches, say, than formerly. The affected individual may not notice the difference at all, or if he notices, will most likely shrug and ascribe it to 'getting older.' Impairment of neuromuscular functions is not measurable through the cholinesterase test referred to a moment ago, but we in California are working on new methods for directly measuring these kinds of pesticide 'poisoning'."[48]

Several studies in the U.S.A. and abroad involving human and animal subjects indicate that chronic exposure to organophosphate and other pesticides can have neuromuscular effects, that it can affect such factors as serum creatine phosphate, glutonic oxalic transaminase, cholesterol, and urine protein levels, and can cause damage to such organs as the liver and kidneys.[49,50,51,52,53,54,55,56,57,58,59,60] The possibility of carcinogenic, teratogenic, and mutagenic effect is another factor that must be taken into account in pesticide usage.

To sum up, then, there is evidence for several adverse health effects resulting from chronic pesticide exposure. These include damage to the nervous system with such accompanying effects as muscular weakness, difficulty in sleeping, damage to the liver and kidneys, and possible development of cancer. These effects can occur even when no acute symptoms (such as those accompanying cholinesterase inhibition) are present, and may occur even when cholinesterase depression is not detectable. Virtually, no work has been done which would indicate a dose-response relatio[illegible]or any of these effects. At this time we can only conclude that at present levels of exposure, long-term contact with pesticides is likely to produce one or more of these effects among a large number of persons occupationally exposed. Any sizeable reduction in pesticide use, therefore, would probably make a goodly contribution to the health of persons occupationally associated with pesticides, or otherwise exposed to pesticide residues.

In this latter connection, the general public is exposed to pesticides largely in the form of residues in produce that has been sprayed in the field. These residues are generally of magnitudes of 1 ppm, or less. Such residues are too small to cause any acute effects, the amount ingested as residues on produce being far less than those impacting on persons occupationally exposed. Although there are no acute effects from such exposures, the possibility exists that certain chronic effects can be caused by continued ingestion of pesticide residues.

Not the least consideration here, is the possible synergistic or potentiation effect that may occur where mixtures of molecules (which may not necessarily be exclusively pesticidal) occur. Synergism and potentiation are known to occur where mixtures of pesticides or pesticides and other chemicals exist. Thus, whether exposure occurs in the field or through ingestion of minute residue of the chemicals in produce, the phenomena of synergism and potentiation must be of concern to us and measures taken to minimize the chances of their occurrence.

Thus, until it can be shown that the types of low level exposure to pesticides just described are not a real threat to human health, every effort should be made to keep pesticide usage at a minimum. Specifically, in food production the use of pesticides should be related to maintaining or increasing yields and to assuring the real needs of produce quality. But, in this usage of pesticides the goals of high yield and quality should not be attained at undue risk to human health and environmental quality. In this latter connection it is particularly important that frivolous or superfluous pesticide usage based on invalid cosmetic or pest contamination standards be avoided.

Pesticide Use and Regulations--Footnotes

1. *Pesticide Use Report, 1973*, Agircultural Chemicals and Feed, California Department of Food and Agriculture, Sacramento, California. p. 289.
2. Harrison C. Dunning, "Pests, Poisons, and the Living Law: the Control of Pesticides in California's Imperial Valley," *Ecology Law Quarterly*, Fall, 1972. p. 636n.
3. *California Agriculture 1970, A Report on California's Principle Crop and Livestock Commodities*, California Department of Agriculture, 1971.
4. David Pimentel, "Extent of Pesticide Use, Food Supply and Pollution," New York Entomological Society, March, 1973. p. 15.
5. C. B. Christensen, *Pesticide Use Report*, 1974, California Department of Food and Agriculture, Sacramento, California, 1975.
6. *Ibid*, p. 179.
7. Anonymous, *Statistical Abstracts of California*, Sacramento, California,
8. C. B. Huffaker and Ray F. Smith, "The IBP Program on the Strategies and Tactics of Pest Management," *Proceedings, Annual Tall Timbers Conference on Ecological Animal Control by Habitat Management*, Feb. 24-25, 1972. p. 220.
9. Pimentel, *op. cit.*, pp. 27, 29.
10. Robert F. Luck, R. van den Bosch and R. Garcia, "Chemical Insect Control, A Troubled Pest Management Strategy," *Bio-Science*, (in press).
11. "The Principles, Strategies and Tactics of Pest Population Regulation and Control in Major Crop Ecosystems," *Proceedings, IBP Integrated Pest Management Conference on Economic Injury Evaluation*, April 5, 6, 1973, Dallas, Texas. p. 18.

12. G. Feder and U. Regev, "Biological Interactions and Environmental Effects in the Economics of Pest Control", Journal of Environmental Economics and Management, 2, 75-91 (1975).

13. Rosemarie Von Rümker, Farmer's Pesticide Use Decisions and Attitudes on Alternate Crop Protection Methods, U. S. Environmental Protection Agency, Washington, D. C., 1974. p. 3.

14. Ibid., pp. 5, 6.

15. IPMSA brochure, IPMSA, 100 North Winshester Blvd., Suite 260, Santa Clara, California 95050.

16. C. M. Merritt, Department of Entomological Sciences, University of California, Berkeley, personal communication, January, 1975.

17. A. Gutierrez and W. Loew, "Pest Control Decision Making in California Cotton", in progesss.

18. W. R. Willey, "The Diffussion of Pest Management Information Technology", doctoral thesis, University of California, Berkeley, 1974. pp. 10, 11.

19. D. C. Hall, et al., "The Performance of Independent Pest Management Consultants in San Joaquin Cotton and Citrus", California Agriculture, October, 1975, p. 12.

20. Willey, op. cit., p. 105.

21. Personal communications with growers who wish to remain anonymous.

22. Delvan W. Dean, pers. comm., Chemicals and Feed Division, California Department of Food and Agriculture, July 15, 1974.

23. E. S. Greenstone, "Farmworkers in Jeopardy: OSHA, EPA and the Pesticide Hazard", Ecology Law Quarterly, Vol. 5, No. 1, p. 69, 1975.

24. Ibid., p. 121.

25. Dunning, op. cit., pp. 639, 640.

26. Dunning, *op*. *cit*., p. 651.

27. Dunning, *op*. *cit*., p. 652.

28. R. Howitt, doctoral thesis, University of California, Davis, 1975.

29. Dunning, *op*. *cit*., p. 648.

30. Robert Howie, pers. comm., August 6, 1974; Claude Finnell, pers. comm. August 8, 1974.

31. Dunning, *op*. *cit*., p. 655.

32. Barry Wilk, pers. comm., March, 1975.

33. Pers. comm. with State Department of Food and Agriculture, Licensing Division, January, 1975.

34. Everett J. Dietrick, Riverside, California, personal communication.

35. Dunning, *op*. *cit*., p. 675.

36. Dunning, *op*. *cit*., p. 675.

37. Dunning, *op*. *cit*., p. 678.

38. Dunning, *op*. *cit*., p. 678n.

39. D. Pimentel, Ecological effects of pesticides on non-target species. Executive Office of the President, Office of Science and Technology. June, 1971. U. S. Printing Office Stock No. 6106-0029. 229 pp.

40. R. L. Rudd, Pesticides and the living landscape. Univ. of Wisc. Press. 320 pp. 1964.

41. R. K. Tucker and D. G. Crabtree, Handbook of toxicity of pesticides to wildlife. Resource Publication No. 84. U. S. Dept. Inter. Fish and Wildlife Serv. 131 pp. 1970.

42. State of California, Department of Health and Department of Food and Agriculture. Illness of employed persons reported by physicians to the state as due to exposure to pesticides or their residues according to type of illness. 1975. 1 page.

43. Dr. Kahn made this comment in a seminar held in the Biological Sciences Department, Stanford University, on May 3, 1976. During this discussion he presented data supportive of his conclusion.

44. California Community Studies on Pesticides, Contract Report #19. Jan. 1-Dec. 15, 1969.

45. R. Howitt, Ph.D. Thesis, University of California, Davis. 1975.

46. Hearing held in Sacramento on November 16, 1976.

47. Howitt, *op. cit*.

48. T. Milby, Testimony on Federal Environmental Control Act of 1971. Hearings before Senate Subcommittee on Environment Serial #92-80, p. 397.

49. K. Jager, et al., Br. J. Ind. Med. 27: 273. 1970.

50. Dreuth, et al., Arch Envir. Health. 25: 395. Dec., 1972.

51. L. Schmertzler, "Achilles tendon reflex force as a sensitive test for organophoshate exposure." To be published.

52. Rayner, et al., pers. comm., Chem. Path. and Pharm. 4(3). Nov. 1972.

53. F. Medred, Residue Reviews 6: 42.

54. L. Reiter, G. Talens, D. Woolie, Proc. West Pharm. Soc. 15: 123, 1972.

55. Tocci, et al., Ind. Med. Sur. 38(6): 188, 1969.

56. J. Davies, *In* Proc. of Nat'l. Conf. on Protective Clothing and Safety for Pesticide Workers. Atlanta, Ga., May, 1972.

57. M. Wasserman and D. Wasserman, *In* "Fate of Insecticides in the Environment." S. A. Tahori (Ed.), Butterworth, London. 1972. p. 521.

58. F. Kaloyonova-Simeomova, Report at meeting of subcommittee on Pesticides of International Association of Occupational Health. Amsterdam, 1971. Summary of Conference in Arch. Envir. Health 25, Dec., 1972.

59. M. Boguzs, Clin Chim ACTA 19: 367. 1968.

60. T. Nakazawa and T. Nakazawa, J. Japan Assn. Rural. Med. 22(6): 756. 1974.

CHAPTER 3. AN IN-DEPTH CASE STUDY OF PESTICIDE USE FOR COSMETIC QUALITY STANDARDS.

In this chapter a specific crop is assessed regarding cosmetic quality standards and their possible effects on pesticide use decisions. The crop, California navel and Valencia oranges, is primarily a fresh market one. Cosmetic quality standards may also play an important role in crops produced entirely for the processing market, as we have indicated in Chapter 1.

CITRUS

I. SUPPLY AND DEMAND

CITRUS ACREAGE AND PRODUCTION

The citrus industry is an important part of California agriculture. California oranges ranked as the state's number one crop between 1930 and 1950 in terms of cash value. Since 1950 citrus has fallen in relative importance, but was still the number ten crop in the state in 1969.[1] Navel and Valencia oranges account for seventy percent of the California-Arizona citrus crop, while lemons make up another 20 percent.[2] We shall restrict most of our discussion to the orange crop.

THE FRESH MARKET

California Navel and Valencia varieties tend to have a lower juice yield than Florida oranges, a more cosmetically attractive exterior color, and they tend to have a higher level of citric and ascorbic acid which are associated with taste and nutrition.[3] Since the California citrus industry was more or less fully developed before the advent of frozen orange juice concentrate it is geared, in other ways, toward the fresh market. The quality standards which prevail in California are designed to meet the demands of the fresh market. The major marketing cooperative of California-Arizona oranges, Sunkist Growers, Inc. has spent many years and millions of dollars to cultivate and maintain a market image for fresh citrus.[4] Consequently, the financial well-being of California-Arizona orange growers has been tied to the state of the fresh fruit market. Table 4 gives data on the return to California citrus growers for Navel and Valencia oranges utilized in the fresh and by-products markets. The data indicate that California-Arizona orange growers have made little or nothing on oranges sold to the processing market. They must sell a large percentage of their crop to the fresh market. This is in contrast to the Florida citrus industry where the prices received for citrus for processing are comparable to those received for citrus for the fresh market.[5]

THE PROBLEM OF OVER-PRODUCTION

The California-Arizona citrus industry has suffered from the problem of "over-production." There are several possible factors that contribute to this problem. The per-capita consumption of fresh oranges has declined sharply in recent years. Between 1945 and 1960 per-capita consumption declined from 37.9 pounds per year to 16.2 pounds per year. Since 1960 the per-capita consumption has remained essentially constant at about 16 pounds per year. In terms of total consumption, the utilization of fresh citrus declined from 72 million boxes in 1945 to 38 million boxes in 1962.[6]

In addition to slackening per-capita demand for fresh citrus, the grower has been receiving a decreasing proportion of the total return on citrus. Marketing margins, the difference between the price paid by the consumer and the amount received by the producer, have been increasing since 1950 for oranges. In particular retailer margins have increased dramatically since 1950. It should also be noted that when supplies of oranges are low and the retail price is high the proportionate return to growers is relatively high, whereas when supplies of oranges are high and retail prices relatively low, the retailer margin is relatively high.[7] This is a special case of the general observation by Jamison that, "The grower demand curve is generally price inelastic in the relevant output range while the demand facing the marketing firm is generally elastic. Total revenue maximization therefore calls for opposite control policies at these two levels--e.g., growers, as a group, gain from decreased quantities sold and marketing firms, as a group, gain from increased supplies.[8]

Given this situation, of decreasing per-capita demand for fresh citrus and a decreasing proportionate return to the grower, we might expect to see a pattern of decreasing acreage and production of California-Arizona citrus in the post 1950 era. However, this is not the case. California orange acreage did, in fact, decline from 235,000 acres in 1945 to 132,000 acres in 1961.[9] However, this was due primarily to the urbanization of the Los Angeles basin. Starting in 1960, California acreage started to increase rapidly to about 230,000 acres in 1970. Since 1970 California acreage in oranges has remained fairly stable. Orange acreage continued to decrease in the Southern California growing region in the sixties, while there was a steep increase in orange acreage in the Central California growing region, and an increase of lesser magnitude in the Arizona-California Desert region. The increased acreage was disproportionately allocated to the production of navel rather than Valencia oranges.[10]

This pattern of acreage increase in the 1960's is explicable for the following reasons. Growers who were forced out of production in the Los Angeles area due to urbanization undoubtedly received very substantial capital gains upon the sale of their land. It would seem logical, from the viewpoint of an individual grower, to reinvest this capital in new orange acreage in Central California where the weather was conducive to citrus production, water was available and land was relatively cheap. For navel oranges grown in Tulare county in 1971 the cost per acre for water was $36 and the cost per acre for taxes $64. For San Bernardino County the respective figures were $64 and $125. For Valencia oranges grown in Tulare County in 1971 the cost per acre for water was $36 and taxes were $55 per acre. The respective figures for Valencias grown in Orange County was $80 and $150.[11] It would be logical to invest in navel rather than Valencia oranges since a higher percentage of navels make it to the fresh market, and therefore the potential return is higher on navels. In addition, under the federal tax laws operative in the 1960's citrus growers were allowed to count cash expenditures on orchard development as capital expenses. Thus, the investor could deduct depreciation, cultural costs, interest, taxes and management fees associated with establishing the citrus orchard, from other income. After the orchard was established the cost of planting the trees was depreciable over their useful life. This incentive toward "tax shelter farming" undoubtedly contributed to the expansion in citrus acreage in Central California. The Tax Reform Act of 1969 wiped-out the tax shelter provisions for citrus and almond orchards and this may account, in part, for the leveling off of citrus acreage since 1970.[12,13,14]

The 1950's and 1960's were also periods of increasing population and increasing real income. Both these factors could be expected to contribute to an increase in the total consumption of fresh citrus. The larger the population, especially in California where fresh citrus consumption is relatively high, the larger the total consumption of the fresh product. Since the demand for citrus has been shown to be income elastic, that is families with higher incomes purchase more citrus per-capita, an increase in real incomes for all families would be expected to result in an increase in total consumption of citrus. If these were the expectations of the 1960s they have not been fulfilled by the 1970s. The population growth-rate is declining as is the level of real family income.[15] It is not clear that either of these trends are likely to be reversed before 1980.

The combined effect of these factors, some of which induced an expansion of citrus acreage for reasons unrelated to consumer demand, is evident in the data for the percentage of California-Arizona citrus that is actually sold to the fresh market. For Valencia oranges, the percentage of the crop sold to the fresh market averaged about 67 percent in the period 1950-1960. Between 1960 and 1973 the percentage of the valencia crop sold to the fresh market under-went a steady decline, averaging 60 percent for the period 1960-1973. Navels follow a similar pattern. In the period 1950-1960, 88 percent of the navel crop, on the average, was sold to the fresh market. For the period 1960-1973 this figure dropped to 78 percent.[16] The season average on-tree returns for California oranges, which had been increasing between 1950 and 1960 also declined between 1960 and 1973.[17] These various trends are illustrated in figures 1, 2, and 3 and Table 5.

The situation in citrus production seems to fit the general model of economic behavior described by the National Commission on Food Marketing:

> For a variety of reasons bearing acreage of some perennial crops exhibits broad, cyclical movements. The basic cause of such cyclical movements appears to be the tendency of producers to formulate expectations of future price of a commodity upon the current price or those prices of the recent past. If expectations of earnings are high for a single commodity relative to those for alternative uses of resources in some given period of time, planting of the former commodity tends to increase. As plantings come into bearing in a subsequent period, production rises and prices falls, other things being equal. At that time the cyclical movement tends to reverse. Because of the perennial nature of the crop and the relatively high proportion of fixed to variable costs involved in bearing acreage, resource adjustments occur in a laggad and sluggish manner. Price may remain comparatively low for several years during the cyclically high level of bearing acreage. In time, the price and market mechanism would bring about adjustments in resource use. In the meantime, owners of resources are concerned with the short run and the hardship which the impersonal forces of the market might invoke.[18]

Given this situation in California citrus, food quality standards take on a critical role. Quality standards are the mechanism by which the citrus crop is allocated between the fresh market and the juice and by-products market. From the viewpoint of the entire industry this allocation is necessary in order to stabilize the industry and maintain adequate returns to growers as a whole. From the viewpoint of the individual grower, quality standards are important because his returns become dependent upon maximizing the proportion of his crop that is allocated to the fresh market.

II. COOPERATIVES AND MARKETING ORDERS

The situation that prevails in citrus production, the low rate of return and fluctuating price structure, the inordinate degree of market power of the input and retail sectors; these factors have long been recognized by citrus growers and agricultural economists concerned with California agriculture. Two basic institutional arrangements have been constructed in an attempt to stabilize intra-seasonal and inter-seasonal prices and increase the general level of grower return. These institutions, each of which make the grower exempt from certain provisions of anti-trust law, are the marketing cooperative and the marketing order.

The dominant marketing cooperative for California-Arizona citrus is Sunkist Growers, Inc. which markets about 80 percent[19] of California-Arizona citrus and represents 8,500 citrus growers.[20] Under the provisions of the Capper-Volstead Act of 1922 Sunkist growers are allowed to join together into one organization for the collective processing and marketing of their fruit without being held in combination or conspiracy. However, in *Case-Swayne Company, Inc. v. Sunkist Growers, Inc.* the U.S. Sumpreme Court ruled, in 1967, that Sunkist no longer qualified for exemption under the Capper-Volstead Act because 5 percent of its membership consisted of corporate growers having their own packing houses and 15 percent were private corporations and partnerships owning and operating packing houses for profit, whose relationship to growers was defined not by a cooperative agreement but a cost-plus-fixed-fee marketing contract.[21] Since 1967 Sunkist has reorganized to comply with the Supreme Court ruling.[22] However, as recently as 1974 Sunkist still listed Goodyear Tire & Rubber Company and Kaiser Aluminum and Chemical Company among its grower-members. The practice of allowing giant corporations like these to take advantage of the Capper-Volstead exemption, which was meant to give economic power to the small farmer, has been criticized by some.[23]

Each member of Sunkist is also a member of a local association or district exchange. The members, whether they market through a cooperative packing house or a private packing house licensed by Sunkist, elect representatives at the level of the district exchange. The most important mechanism of communication between Sunkist management and the grower-members is the annual meeting of Sunkist. In addition, according to Sunkist representative, Curtis Anderson, "Many opportunities are provided each year for growers to attend local and central organization board meetings, to hear how their business is being conducted."[24]

Sunkist has engaged in substantial promotional activities, spending $38 million between 1934 and 1960 for radio, television, newspaper and magazine advertisements designed to build a quality image for fresh California citrus.[25] In order to maintain the quality reputation of the Sunkist trade-mark, Sunkist issues a set of quality standards in excess of statutory state quality standards, which must be adhered to by all packing-houses that market through it. (See Table 1 for comparison of Sunkist and state quality standards.) It has been estimated that the Sunkist quality reputation confers a price premium of five to ten percent on Sunkist products over the prices of competitive products.[26]

Sunkist also plays a significant role in the administration of the marketing order under which the California-Arizona orange industry operates. The marketing order itself specifies that five out of the eleven members on the Administrative Committees of the orange marketing orders shall be members of Sunkist.[27]

The other major citrus marketing cooperative in California-Arizona is Pure Gold, Inc. which markets about ten percent of the crop. The giant vertically integrated agribusiness corporation, Tenneco, currently markets about five percent of the California citrus crop. Tenneco is attempting to increase its share of the fresh produce market through aggressive marketing which places special emphasis on the cosmetic appearance of the produce and on increased packaging designed to appeal to consumer reflexes.[28]

Taken together, the top four firms (e.g., cooperatives) in citrus marketing account for about 90 percent of the market. A concentration ratio of this magnitude would ordinarily be taken to represent a high degree of monopoly power.[29] Under the Capper-Volstead Act, marketing cooperatives are allowed to possess monopoly power as long as it is not exercised to produce anti-competitive effects.[30] In any case, it is doubtful that citrus marketing cooperatives really possess the kind of monopoly power that the concentration ratio would appear to suggest. The marketing cooperatives face a retail sector that is also highly concentrated and well coordinated.[31] In addition, the over-production problem we have already described puts the marketing cooperatives at a great disadvantage when bargaining with retailers. The Capper-Volstead Act, which allows/what the organization of marketing cooperatives does not, however, allows the organization of cooperatives which function to control the total production of citrus products.

MARKETING ORDERS 907-908.

The California-Arizona orange industry also functions under federal marketing orders, the intent of which is to stabilize the price level for oranges and to increase the net returns to growers. These marketing orders are made possible by the Agricultural Marketing Agreement Act of 1937, the federal law which exempts the activities of marketing orders from certain anti-trust provisions.

Charles Teague, the visionary president of Sunkist, in the 1930's and one of the pioneers of citrus marketing orders, explained the purpose and function of the citrus marketing order in a 1938 radio broadcast, in which he stated:

> Supply and demand set the price. When supplies are in surplus they must be regulated. Otherwise prices will fall until they do not cover packing costs and freight.
>
> A small surplus is all it takes. If unregulated, it can be just as disastrous as a large one.
>
> Regulation of supplies must take place at the source of production. For we are dealing with perishables. And once a surplus of perishables is shipped to market it will be sold even if the price does not cover the freight charges.
>
> There are only two ways of regulating at the source:
>
> 1. By cooperative control of the product.
> 2. By prorate agreements, either State or Federal, or both.
>
> . . . There is probably a lack of understanding among growers and the public alike, of the difference between regulation of shipments and elimination of surplus. We regulate shipments to improve returns to growers and insure a steady supply and reasonable price to consumers, even when all the production is marketed over the season. But in some years the crop is larger than can be marketed at any return to the growers. Then it becomes necessary not only to regulate the quantity shipped each week, but also to divert the surplus to by-products, or otherwise eliminate it from fresh fruit trade channels.[32]

The present marketing orders governing oranges, marketing order 907 for navel oranges and marketing order 908 for Valencia oranges, came into being in the 1950's.[33] Each of these marketing orders is managed by an Administrative Committee composed of six growers, four handlers, who may also be growers, and one non-industry member who has always been nominated by the other members to serve as the chairman of the Administrative Committee.

Under the provisions of the marketing orders three of the grower members and two of the handler members of the Administrative Board must belong to Sunkist Growers, Inc. The other marketing cooperatives, Pure Gold, Inc. and Gold Banner Association get one grower and one handler member each, and two grower members and one handler member are chosen to represent independent growers and handlers. The Administrative Committees require six concurring votes to take any action.[34] Obviously, with five votes, Sunkist has a good chance of dominating the policy of the navel and Valencia Administrative Boards. Some non-Sunkist growers and handlers have complained about Sunkist domination of the Administrative Boards.[35] There is certainly a possibility of a conflict between Sunkist and non-Sunkist interests in regard to marketing order policy since Sunkist enjoys a special reputation for quality not shared by non-Sunkist growers and handlers. Thus, Sunkist may wish to set a marketing policy based on higher prices and lower market volumes than non-Sunkist people would like to see.

The orange Administrative Committees are empowered to establish a "best" policy for the marketing of California-Arizona oranges. A "best" policy, presumably, is one which minimizes price fluctuations and maximizes returns to the grower. In order to achieve the goals of this policy the Administrative Committees collect and analyse information on the available crop of oranges, including estimated quality and composition of sizes, the estimated utilization of the crop, available supplies of competitive oranges, the level and trend of consumer income, estimated supplies of competitive citrus commodities, and any other pertinent information. Based upon this information the Adminsitrative Committees produce a schedule of estimated weekly shipments designed to meet the goals of their marketing policy.

The recommended weekly volume of orange shipments, which may be revised as the season progresses, is implemented by a system known as Pro-rate. Under the pro-rate system the weekly quantity of oranges that may be shipped to the fresh market is fixed for each of the three growing regions in the California-Arizona market. Each packing house is allocated a specific percentage of this quantity based upon its percentage of the total production of the pro-rate region. The packing-house is thus constrained to allocate only a certain proportion of each grower's crop to the fresh market. The mechanism by which this allocation takes place is the enforcement by packing-houses of the quality standards established by marketing cooperatives. The administrative committees may also regulate directly the size of oranges that are allowed to be sold on the fresh market. Specific exemptions from regular allotments are allowed in the case of early maturing fruit, fruit with a short-tree-storage life, and for weeks of the season in which freeze damage takes place.[36]

The orange marketing orders do not apply to fruit that is sold for processing into juice and by-products or to fruit that is exported to countries other than Canada. The marketing orders have no effect on the development of new orange acreage or the entry of new growers. As a result, while intraseasonal price fluctuations have followed a fairly stable pattern, interseasonal prices do not.[37] In addition, it is doubtful that the operations of the orange marketing orders can have any significant effect on the over-production problem. The marketing order could effect over-production only if there were no commodity substitute available for California-Arizona fresh oranges. While this is true to a great extent from the consumer's point of view, it does not mean that highly concentrated retailers may not choose to feature other commodities than oranges if they perceive that the weekly volume flow of oranges is being unduly restricted.[38] The resultant drop in wholesale price might force the Administrative Boards to restrict the flow to even a greater extent in an attempt to make up for the loss in projected revenues. If this tendency exists, as the pattern of declining fresh market allocations and declining power returns indicate it might, then it might also be dampened by the promotional activities of Sunkist, which retailers may exploit in their own promotional activities.

Under the Pro-rate system, critically important in determining the grower's returns is the size distribution of the fruit, which is beyond his immediate control, and quality of the fruit, which is, to some extent, affected by pest control practices. Each grower, then, seeks to increase the total yield of the crop and seeks to maximize the proportion of his crop that is allocated to the fresh market and to the top grade in the fresh market.[39] The long-run consequence of these atomistic efforts may be to decrease the industry-wide average proportion of the crop that is allocated to the fresh market, and this has, in fact, been the case in recent years. The result of this pattern is to increase, even more, the incentive of the individual grower to maximize yield and quality, resulting in increased production costs and increased reliance on input factors. This, along with inflation of input costs, has lead to an increase in the minimal size of the production unit. One grower we spoke to stated that in the 1950's a ten acre orange grove could provide a living income, but today 40 acres is the minimum.[40] Robert Howie, the agriculturalcommissioner of Riverside County also indicated that the smaller orange grower are being driven out of business by increasing input costs.[41,42]

In summary, the institutional arrangements which have been developed in response to the over-production problem, the marketing cooperative and the marketing order, are incapable of directly attacking the root causes of the over-production problem, the disproportionate market power of the input and retail sectors compared to the atomistic production sector. Instead attempts are made to deal with the over-production problem in a symptomatic way, resulting in additional dislocations which may not be beneficial to society. Such dislocations are not a product of insincerity or ineptitude on behalf of orange growers and their institutions, but result inspite of the best motivated and best informed efforts on their part.

Within this system quality standards play an important role, and it is to a consideration of these standards that we now turn.

III. QUALITY STANDARDS

The California-Arizona citrus industry operates under two kinds of quality standards for fresh fruit. In the first instance, the fruit must meet the statutory quality standards which are established and enforced by the state. The California standards require that oranges have a soluble solids (sugar) to acid ratio of eight to one if 25 percent of the surface of 90 percent of the fruit has attained an orange color, and a soluble solids to acid ratio of ten to one if the average surface of 95 percent of the fruit is orange. These state standards clearly relate to maturity and are written so as to ensure that green or sour fruit does not appear on the fresh market.[43]

The statutory standards are not, in reality, the effective quality standards that orange growers must meet. Rather, quality standards of a much more comprehensive and stringent nature are enforced by the orange marketing cooperatives. For example, Sunkist maintains a set of quality standards that specify criteria which oranges must meet in order to be sold under the various Sunkist labels, e.g., "Sunkist," "Excel," "Red Ball" and SK." These standards are shown in Table 1.

The non-statutory standards contain a number of specifications which relate to the external appearance of the fruit and may have no bearing on the taste and nutritional quality of the fruit.

Obviously, the non-statutory standards do not serve as a "standardization" mechanism, assuring to all parties a minimum level of quality, especially in regard to taste and maturity. This is done by the statutory standards, which are, in fact, subsumed as part of the non-statutory standards. It might be thought that the non-statutory standards have been established in response to a consumer preference for high cosmetic quality. This theme has been stressed by numerous commentators, including many of those who are highly critical of the current pattern of pesticide use related to cosmetic quality standards. For example, David Pimentel, writing in the March, 1973 journal of the New York Entomological Society, observes, "Oranges also are in the same category as apples, because of the currently high 'cosmetic standards' now expected by the consumer.[44] P. S. George and G. A. King, agricultural economists with the Giannini Foundation, have indirectly derived an "elasticity of quality" for oranges. This elasticity is slightly negative (-.035) which could mean a number of things; but it at least leaves open the possibility that the current level of quality of oranges is higher than consumer preference would warrant, that is, the level of quality could be lowered without a fall in the price of oranges.[45]

Whatever the current state of consumer preference for cosmetic quality in oranges, it is no doubt, in part, a product of decades of promotional activities by Sunkist rather than just an endogenous property of the human psyche. The Florida "russet grapefruit" which is severely cosmetically affected by mites and whiteflies, receives a premium price because of its high interior quality. In this case, the cosmetic damage has become a trade-mark, as it were, of the high quality of the fruit. The green color of the re-greened Valencia orange is now being advertised as a "guarantee" that the fruit is ripe, which, in fact, it is.[46] Thus, consumer attitude does not seem to be an insurmountable barrier to the alteration of cosmetic quality standards once other obstacles to change have been overcome.

Non-statutory standards may exist for another reason, quite apart from consumer preference, and that is as a mechanism for allocating oranges to the fresh market, in accordance to the policy goals of the orange Administrative Boards. It is in the packing-house that the enforcement of non-statutory quality standards takes place and it is as a result of this enforcement that a certain number of oranges are offered for sale on the fresh market and the remainder diverted to juice and by-products.

This is all of great importance to the grower, for he receives a significantly lower price for oranges that are classified as "Red Ball" rather than "Sunkist" and an even lower price for oranges that go to juice and by-products. For the years 1950-51, 1965-66 and 1967-68, Rausser reports the following composite relative prices that were received for the different grades of navel and Valencia oranges.[47]

Navels	Relative Price	Valencias	Relative Price
Sunkist	1.00	Sunkist	1.00
Excel	.82	Excel	.83
Red Ball	.74	Red Ball	.71

In regard to the price differential between oranges that are allocated to the fresh market and those that are allocated to the by-products market, the data in Table 4 indicate that growers receive little or no return on fruit allocated to the by-products market and that the price situation has constantly deteriorated in the by-products market since 1960.

Data from pack-out sheets that we have received for 1973 and 1974 confirm this general situation. These pack-out sheets, which report to the grower the distribution of his crop into different grades and the prices received, indicate that the grower receives between $.50 and $1.50 less per packed (50 lb.) box for oranges that are graded "Red Ball" or "Choice" rather than "Sunkist" (or "Pure Gold"). Pack-out sheets for navel oranges indicate that growers received from nothing to $10.00 a ton for navel oranges that went to juice and by-products. This latter figure is equivalent to $.25 per box. Obviously, there is a great financial incentive for growers to meet the quality standards that adhere to the top grade for fresh oranges.

An important aspect of the quality standards that are specified by Sunkist is their non-quantitative nature. For example, it is difficult to know exactly what "more than slightly scarred" means. Additionally, the cause of many of the defects is not specified. Scarring may result from a number of factors, including wind, mechanical abrasion by branches, and various insect pests.[48] The wide range of exterior defects specified in the quality standards are not detected by any quantitative technique. Rather, the oranges are screened visually by packing-house workers as they are carried down a conveyor belt. It would seem that the non-quantitative nature of the exterior quality standards and the inspection procedure would allow for the adjustment of the enforcement level of the quality standards without any change in the specification of the quality standards themselves. It has been suggested, for example, that this could be accomplished by simply increasing the speed of the conveyor belt that carries the oranges past the quality inspectors, or by increasing or decreasing the number of inspectors on duty. Spokesmen for Sunkist categorically denied that any "adjustment of the quality standards" takes place.[49] In the strict technical sense of this phrase they are correct.

However, there is evidence to suggest that adjustment of the level of enforcement of quality standards does, in fact, take place. First of all, the decreasing proportion of oranges that are sold to the fresh market indicates that either the actual quality of oranges has been deteriorating or that the level of quality standards enforcement has become more stringent. The first possibility is explicable only if we assume that insect related damage is the predominating factor in determining the level of quality and, furthermore, that orange growers had increasing difficulty in dealing with insect pests in the last decade. Though there may be some element of truth in the latter of these assumptions, they cannot explain the regular decline in the proportion of fruit sold to the fresh market. If this hypothetical quality decline is not due to insect damage it might be due to various cultural and mechanical factors, but here again, there is no reason to expect a regular increase in damage due to these factors. It is much more credible to assume that as orange acreage and production has expanded, the enforcement level for quality standards has had to be annually adjusted to fulfill the marketing policy established by the orange Administrative Boards. This phenomenon should not be all that surprising. In the June, 1972 issue of *Citrograph*, "The Magazine of the Citrus Industry," agricultural economists Leon Garoian and Kirby Moulton wrote, "Certainly at the grower level we've seen the results of low or nonexisting barriers [to entry]. *New growers can raise the required quality of citrus* and can join marketing associations."[50] (emphasis added) Still this issue seems to be a sore point with the marketing cooperatives. As to whether the level of enforcement of quality standards is adjusted during the season, as changes in the weekly volume flow of oranges to the fresh market might suggest, the orange growers we interviewed unanimously and emphatically agreed that this does occur.[51] (See Table 6 for summary of citrus grower interviews.)

When the percentage of fruit that is allocated to the fresh market is regressed against the total seasonal crop, using data for the years 1949-1973 from Table 2. A positive correlation is shown to exist between these two variables (especially when freeze years are eliminated from the data). This would indicate that quality standards are adjusted, at least on an inter-seasonal level. When the same procedure was applied to weekly data for the year 1973-74 no such relationship was found to exist. Thus, at least, according to this test, quality standards do not appear to be adjusted within the season. Thus, pro-rating appears to function fairly well in allocating the volume flow of the average crop within the season, but it fails in controlling the total quantity of oranges from season to season.

The negative result of the second test, above, does not necessarily mean that the individual growers were entirely wrong in their perceptions of intra-seasonal quality standard enforcements. While there was no overall correlation between the percentage of the weekly crop allocated to by-products and the total weekly crop, the weekly data for 1973-74 do appear to indicate a time pattern in the allocation. At least for Navel oranges, the percentage of the crop allocated to by-products increasing throughout most of the season.

These results are summarized in Figures 4, 5, 6 and Tables 3 and 4.

Spokesmen for the citrus industry emphatically deny that there is a cosmetic component involved in the quality standards as far as insect related damage is concerned. Two grounds are cited in support of this position. Richard Breuner, the President of the Industry Committee on Citrus Additives and Pesticides, a citrus industry advisory and lobbying organization, stated that insect related external damage is symptomatic of lower interior quality.[52]

Don Avis, manager of pest control for Sunkist, also contended that any cosmetic effects obtained from pest control are strictly the side benefits of sound pest management practices necessary for the maintenance of fruit yield and tree vigor and, that fruit exposed to proper pest control automatically meets the Sunkist quality standards with regard to insect-related damage. On these grounds Avis denied that the Sunkist quality standards contain any operationally effective cosmetic components.[53]

The viewpoint is not universally shared by the citrus industry. For example, the Florida Department of Citrus initiated a campaign in 1975 in which it "tells consumers that the external appearance of Florida oranges has nothing to do with internal quality—the same climatic conditions that make Florida oranges exceptionally juicy and delicious also mean that they usually carry a few blemishes, wind scars, scale, and sometimes have a pale color or a peel that has regreened."[54]

IV. PEST MANAGEMENT

Citrus is among the top ten food crops in the U. S. in terms of pesticide application. Ninety seven percent of all citrus acreage is treated on a regular basis and citrus accounts for 2 percent of all agricultural insecticide use.[55] In 1973 over twelve million pounds of various pesticides were sprayed on California oranges, according to the California State Department of Agriculture Pesticide Use Report. The chemicals used included such toxic substances as Delnav-dioxathion, Malathion and Parathion.[56] The disproportionately large amount of pesticide use in citrus is reflected in the extremely high pest control costs for this crop. For example, the average pest control cost (excluding control costs for weeds and nematodes) was estimated at $160.00 an acre for the 1973-74 growing season for navel oranges in Central California.[57] The significance of this cost can be appreciated by comparing it to the net return for navel oranges which ranges between $500.00 and $1,000.00 per acre.[58]

There are important variations in the number, type and severity of citrus insect pests according to the growing region. Southern California is relatively inhospitable to a number of important citrus pests, most notably the citrus thrips. In addition, the parasites of certain citrus pests thrive in southern California but not in other growing regions. This is especially true of _Aphytis_ _melinus_ DeBach, an effective parasite on the California red scale.

In the Central California growing region the citrus thrips, the citrus red mite, and the California red scale are major pests. Other citrus pests are also more severe in these regions than in Southern California. From a pest management perspective, the enormous expansion of citrus acreage into Central California was unfortunate. It took place, anyway, for reasons already discussed. In recent years growers in this region have felt the consequences in the form of increasingly difficult pest problems and swiftly rising pest control costs.[59,60,61]

The specific approach toward pest control also depends upon the basic philosophy of the grower and his pest control advisor. There are essentially two approaches to citrus pest control: conventional chemical control and integrated pest management. In conventional chemical control the approach is to suppress specific pests without regard for the long-term effects of chemical treatment or the actual level of the pest population necessary to cause damage of economic significance. This strategy has often led to episodes of unexpected pest resurgence or outbreaks in citrus. For example, an important citrus pest, the cottony cushion scale, was brought under effective biological control in 1892 with the deliberate introduction of its adapted predator, the vedalia beetle. With the advent and widespread use of DDT in the 1940's, the vedalia beetle was decimated in many orange groves. As a consequence there was a serious resurgence of the cottony cushion scale which subsided only when the vedalia beetle was re-introduced to the orchards and the use of DDT was discontinued on or near citrus groves.[62] Currently, attempts to control the citrus thrips through conventional chemical control has led to the elevation of the citrus red mite as a serious pest in California, as well as to the exacerbation of a number of other citrus pest problems. (See discussion of the citrus thrips, below, p. 86).

The integrated pest management approach attempts to take the entire agro-ecosystem into account. The population levels of insect pests are carefully monitored to determine whether economically significant infestations exist, and if so, when and how they can be most effectively controlled. Use is made of cultural techniques, the introduction of predatory or parasitic insects, and the selection and use of chemical materials on the basis of their long-term, as well as short-term, effects on the target pest and the entire agro-ecosystem.

In tables 7 and 8 idealized programs of citrus pest control for Central California based upon the conventional chemical approach and the integrated pest management approach are compared. According to University of California citrus entomologist, C. E. Kennett, citrus red mite falls to low status in the pest hierarchy because integrated pest management consultants attach less importance to it than chemical control specialists. "Citrus thrips retain a high position not so much because of their actual damage potential but more so because the arbitrary classification, by the citrus industry of thrips feeding scars on the fruit as serious damage, does not allow the supervised control specialist to relegate it to a position of lesser importance," Kennett comments.[63]

Richard D. Strong, Commodity Specialist, California Farm Bureau Federation, analyzed comparative cost of conventional and integrated control on Valencia oranges in Tulare County over a five year period. He reported that integrated control programs cost $45 per acre as compared to $101 per acre for conventional control.[64] (See Table 9.)

Hall, Norgaard and True have compared citrus growers who use integrated pest management and those who use conventional chemical control.[65] Thirty-nine orange growers in the San Joaquin Valley were interviewed. Seventeen were clients of independent pest management consultants, while twenty-two were not. An additional eighteen growers in the coastal region of Southern California were interviewed. All of these growers were clients of independent pest management consultants. Differences in the general characteristics of Central California management adopters and nonadopters seem apparent from the survey. On the average adopters have a smaller percentage of acreage in crops other than oranges; they have a lower quality of land as measured by the Storie Soil Index; they watered more often with less water per application; they have fewer trees per acre and younger groves. On the average adopters tend to be better educated, have less contact with their farm advisor, and to read more technical journals. They tend to have less total assets and less total debts and a higher asset to debt ratio than nonadopters. These characteristics vary from grower to grower and this average composite picture cannot be applied to any individual grower. Additionally, the differences between the average adopter and nonadopter are not striking in all of these categories and it cannot be concluded that a cause and effect relationship necessarily exists between these characteristics and the decision to adopt or not adopt integrated pest management advice. Nevertheless, these data are suggestive of what some of the actual factors might be.

When the nonadopters were asked to rank, in order of their preference, their sources of pest control information, 15 out of 22 listed chemical company salesmen as their most preferred source of information. Significantly, none of the nonadopters listed independent pest management consultants, even as a second, third or fourth preference.

The orange growers were also asked to rank reasons for utilizing the type of advice they used. The adopters attributed about equal weight to: "respect for and friendliness with the advisor,""a lower cost of pest control," and "a lower risk of pest damage." The nonadopters weighted "personal respect and friendliness" much higher than other factors and also listed "free advice of the chemical company salesman" as the second most important factor. These responses would seem to indicate that the nonadopter is being "sold" more on the personality of the salesman than on the effectiveness of the pest control procedure. This conclusion is supported by the fact that most nonadopters, as well as adopters, agreed that integrated pest management is cheaper and more effective than conventional chemical control.

It is difficult to know to what extent the attitudes of adopters and nonadopters is the cause of their decision to adopt or not adopt independent pest management consultants or the effect of having done so. In any case, grower attitude, though probably very important, may not be the only barrier to the greater use of independent pest management consultants. Another barrier is the economic difficulty of an advisor starting an independent small business enterprise, especially when competitors in the market are the salaried and commissioned salesmen (fieldmen) of large chemical corporations.

The Hall, Norgaard and Tree Study yields the following information on the actual economic effects of independent pest management.[66] The average net return per acre for San Joaquin Valley adopters was $480.00 while for the nonadopters it was $460.00. Other things being equal, the adopters of independent pest management have not been adversely affected financially. The adopters also experienced a significantly lower average per acre pest control cost than the nonadopters, even when the pest management consultant's fee is added in. The average per acre expenditure on insecticides reported in the survey was $20.53 for the adopters and $42.35 for the nonadopters over the years 1970 and 1971. When Norgaard, Willey and Hall applied regression analysis to the information from the survey results, the following estimates were obtained for the profit accruing to the grower as a result of adopting independent pest management. For 1970 the 90 percent confidence interval for the average profit realized by adopters, attributable to independent pest management, was -$14.44 to $153.03 per acre. For 1971 the interval was -$8.56 to $159.07 per acre. The location of these confidence intervals indicates that adopters could expect to have benefited from independent pest management. The analysis also suggests that there is a likelihood that one-third of the nonadopters in the sample would also have benefited from using independent pest management if they were to become adopters.

The relatively favorable environment for natural pest control of coastal Southern California was also confirmed by this survey. When growers were asked to estimate the percent pest damage loss if no pesticides were used, the San Joaquin adopters gave an average estimate of 40 percent while the Southern California adopters gave an average estimate of only 7 percent. The actual level of pest damage loss reported by the two groups was 22 percent and 2.5 percent respectively.

A notable example in which citrus growers have taken advantage of the favorable environment of coastal Southern California and integrated pest management is the Fillmore Citrus Protection District, in Ventura County. It is a citrus grower's cooperative pest control association which is responsible for the maintenance of insectaries, for the release of predators and parasites of citrus pests into the groves of its member growers, and for the general citrus pest management on the 8,000 acres of orchards over which it has jurisdiction. The organization has been heavily involved with integrated pest management and biological control since 1922. Red scale and black scale are under relatively effective biological control in the Fillmore District and the amount of chemical treatment used for the control of other insect pests is relatively low. In 1973, a fairly typical year of the 8,000 acres in the Fillmore District, 660 acres were treated for black scale, 75 acres were treated for red scale, 200 acres were treated for aphids, 800 acres were treated for citrus thrips, and 2100 acres were treated with a medium oil spray designed to prevent the fall and winter build-up of red spider mites.[67]

Currently, any pest control strategy, conventional chemical or integrated management, must take cosmetic factors into account. When we asked nine citrus growers to list insect pests which they considered partially or wholly cosmetic eight listed citrus thrips, four listed citrus red mite, five listed red scale and one listed worms. When asked to estimate the proportion of their pest control cost that is attributable to cosmetic pests, the average estimate was 71 percent, with a range from 50 percent to 100 percent. When asked if they were able to take full advantage of integrated pest management under the existing quality standards, eight of the nine said they were not.[68] For these growers, then, there is a definite relationship between quality standards which they consider cosmetic and their mode of insect pest management, including the degree to which they must use chemical pesticides. This response also indicates that at least eight of the nine growers defined "cosmetic quality standards" in a way consistent with the definition used in this report. That is, these growers understood "cosmetic damage" to refer to revenue loss due to down-grading of fruit and not related to yield loss, or deterioration of fruit flavor, nutrition or storability. (See Table 6.)

V. THE CITRUS THRIPS

If any major agricultural insect pest has gained a reputation for causing essentially cosmetic damage, it is the citrus thrips, Scirtothrips citri (Moulton). Yet, even in this case controversy rages as to the nature of citrus thrips damage. In an evaluation of whether, or to what extent, the citrus thrips should be considered a cosmetic pest, a complexity of factors must be taken into account, including the nature of the damage caused by the insect pest, the age and location of the citrus grove, current and past environmental conditions, current and past cultural and pest management procedures, prevailing and projected economic conditions and quality standards. Many of these factors have been discussed above and it is within this context that the nature of citrus thrips damage will be examined.

HISTORY

The citrus thrips was first identified as an insect pest in California in 1908 after a severe outbreak of thrips-related damage to the Tulare County citrus crop. A 1918 report of citrus thrips by the United States Department of Agriculture[69] provides us with information on the nature and extent of thrips damage before the era of effective control. The report notes that severe infestations of citrus thrips can cause stunted growth on nursery stock and young groves. Severe infestations can also result in fruit drop and the splitting of fruit, as well as substantial deformation of fruit. Certainly this type of damage must be classified as noncosmetic. However, according to the 1918 USDA report, such damage was relatively rare even when thrips were left totally uncontrolled. Fruit drop occurred only "in exceptionally severe infestations," thrips were responsible for "only a small proportion of the usual fruit splitting," and substantial malformation due to thrips occurred in from one to six percent of the orange crop. This is not to dismiss the fact that certain groves at certain times suffered severe damage due to thrips. But, as the 1819 USDA report observed:

> The most important damage resulting from the feeding of thrips upon trees that have passed the period of rapid growth is the lowering of the market value of the fruit by unsightly scabbing and scarring. Although the eating quality of the orange is not affected thereby, its commercial grading is lowered considerably and the selling price correspondingly reduced.

Specifically, it appears that the typical mature citrus grove is primarily susceptible only to the characteristic "stem-end ring scarring" of fruit which occurs without significant loss of fruit yield or tree vigor. The extent to which such damage constitutes an economic loss to the grower depends not only on the severity and incidence of scarring, but on the level and enforcement of quality standards. In the case of citrus thrips scarring other than that which causes splitting or substantial deformation of the fruit, applicable quality standards seem to fall into the cosmetic category.

In the severe thrips year of 1909 more than 80 percent of the oranges in Tulare County were so damaged by citrus thrips as to lower the grade of the fruit. In 1910 this figure fell to 63 percent even though no treatment procedure was available at the time. In the fairly typical season of 1911 it was estimated that the economic loss to San Joaquin Valley citrus growers due to citrus thrips damage was in excess of $180,000. This would certainly be an incentive to control citrus thrips' scarring to a level of noncosmetic damage.

A 1938 report by the University of California Agricultural Experiment Station[70] concurs with the 1918 USDA report regarding the nature of thrips damage. As to tree damage it comments, "Citrus nursery stock and young groves are often stunted and malformed by thrips' attack." On fruit damage the report states, "The fruit injury is rarely severe enough to cause dropping or malformation, although some splitting is attributed to excessive thrips' attacks. Though the eating quality remains unaffected by the surface scarring, the market grade is definitely lowered and the selling price reduced." According to the 1938 report, thrips' damage in the Central California growing region was reduced to 3.8 percent of the fruit by a control procedure involving a series of three sulfur treatments. With no treatments 46.6 percent of the fruit was affected by citrus thrips. What proportion of this damage resulted in grade lowering and what proportion resulted in more severe damage is not stated in the report.

CURRENT STATUS

Contemporary opinion on the nature of citrus thrips' damage is mixed. Certainly, citrus thrips is still considered a major insect pest in California. According to estimates by Ronald M. Hawthorne, survey entomologist for the California Department of Agriculture, citrus thrips accounted for $8,762,922 in crop damage in 1974. This figure is based upon estimates submitted by county Agricultural Commissioners and is probably rather inaccurate.[71] However, it may serve, at least, to indicate the order of magnitude of the problem. According to the same source an additional $2,024,898 was spent in 1974 in attempts to control the citrus thrips, bringing the total direct economic loss attributed to citrus thrips to about 10.8 million dollars.

In the Desert and Central California growing regions the citrus thrips is considered a leading insect pest. In a 1973 article on "Citrus Pest Management Studies in Tulare County," University of California entomologists, D. L. Flaherty, J. B. Pehrson, and C. E. Kennett write, "Thrips are rated high as pests in Tulare County. The fruit must meet marketing standards:

too much scarred fruit results in heavy culling and reduced grade, both influencing grower profits."[72] The "1974-75 Treatment Guide for California Citrus Crops," published by the University of California, recommends treatment for citrus thrips "to prevent fruit scarring" implying that thrips' damage is primarily cosmetic.[73] In a 1971 newspaper account Don Avis, manager of pest control for Sunkist Growers, Inc. "acknowledges that the thrips damage to citrus is mostly cosmetic in nature."[74] According to the 1974 Sunkist Citrus Defects Market Handbook, "The interior quality of the fruit is not affected (by citrus thrips' scarring)."[75]

As we mentioned above, some citrus growers consider citrus thrips a cosmetic pest. In the previously discussed survey, it was listed as a major pest more times than any other insect and it was designated either wholly or partially cosmetic by all of those who listed it. It was mentioned specifically by several growers as constituting a large part of cosmetic pest control costs and as a barrier to more effective utilization of integrated pest management.

On the other hand, Avis, in a recent communication modified his position on the cosmetic nature of citrus thrips' damage, contending that it was not treated as a cosmetic pest as such, but that cosmetic results were achieved as a side benefit of generally sound pest management practices.[76] This position was reiterated by William K. Quarles, Vice President for Government Affairs for Sunkist, who stated, "The current level of pest control activity is necessary to maintain tree vigor, as well as crop productivity at a level of economic necessity for the grower. Most pest control activity has a side benefit of improving the cosmetic appearance of the fruit, but there is little use of chemicals for purely cosmetic purposes."[77]

In a recently published report on citrus thrips' treatment, Elmer, Ewart and Brawner[78] noted that:

> The ring-scar on the stem end of the fruit is of primary concern along with scars caused by feeding of the rind along the sides of the orange. There is no evidence that these scars affect the internal quality of the fruit, but for marketing purposes scarred fruit are given a lower grade in the packinghouse with a subsequent monetary loss to the grower . . . . There is some question about the necessity for using an insecticide to prevent oviposition marks and rind silvering . . . and, besides adding to the grower's costs, these sprays may cause an increase of other citrus pests.

This study also presents evidence which indicates that treatment for citrus thrips had no effect on the growth rate of young orange trees.

In addition, this study provides some evidence that fruit yield was higher in plots where heavy chemical treatment, involving eight applications of organophosphate insecticides per season, was used, than in plots where no treatment was used. However, this study was conducted on young, not mature trees; thus the results cannot be extrapolated to mature, commercially producing groves.

Even for the young trees the results of the study in regard to fruit yield cannot be interpreted unambiguously. The report gives data for fruit yield, over a three year period, for four treatment procedures: no treatment, botanical (insecticide) treatment, light chemical treatment - one application of organophosphate insecticide per year, and heavy chemical treatment - eight applications of organophosphate insecticides per year. The report provides no statistical evaluation so it is difficult to tell whether any of the differences in fruit yield are actually statistically significant. In one year out of three, the yield from the lightly chemically treated plots was actually lower than from the untreated plots. This particular negative result would indicate that, in order to be statistically significant the difference in fruit yield would have to be in the range of 15-20%. (Since the negative result, which was one out of nine total samples, was of the magnitude 6.8%). Thus the only fruit yield differences that might be statistically significant are for the years 1972 and 1974 for the heavy chemical treatment. In a personal communication Dr. Ewart indicated to us that he did not consider his data on fruit yield differences to be statistically significant.[79]

Even if we are to accept the dubious statistical nature of this evidence, there is still another problem. The trees in this study were randomized in this grove. However this procedure does not actually eliminate systematic differences between the sample plots, because eight applications of organophosphate insecticides per year may have effects other than those resulting from thrips' control. It has been shown in other crops, such as cotton, that repeated applications of organophosphate insecticides has a fertilization effect,[80] and a similar possible effect was not assessed in the citrus thrips' study. In addition the report does not indicate how the possible effect of repeated organophosphate treatment on other insect pests was accounted for.

Even if we were to dismiss all of these problems, there is yet another consideration; the economic implication of this treatment procedure. The report does not take this into consideration but some elementary calculations will show how important it is. Assuming that the heavy chemical treatment increases yield by 25%, then for an average mature grove producing 300 boxes per acre (The Tulare County average), this would result in an increase of about 75 boxes per acre. At $2 per box, this would increase grower revenue by $150 per acre. But the cost of eight organophosphate treatments per year, at $20 per treatment per acre, is $160 per acre.[81] Thus there would be a net loss to the grower of $10 per acre, even under very generous assumptions.

Finally, the heavy chemical treatment may have other negative consequences for farmworker and environmental health, and for the long-run stability of the orchard's insect community, as we have indicated.

It is of interest to note that, in apparent reference to the Ewart study, the Sunkist Pest Control Circular for Arizona and California desert regions, which formerly read:

> Citrus thrips attack all varieties of citrus. Control to prevent foliage damage is important on young plantings and in citrus nurseries but is seldom practical on healthy, mature trees. Young fruit of all varieties is attacked from the time it is pea-size to walnut size or larger, which results in scarring and lowering of grade.[82]

has been changed to read:

> University research also indicates that ineffective control of thrips can reduce yields.[83]

This new sentence also appears in Sunkist Pest Control Circulars that recommend treatment for thrips in other citrus growing regions. The pest control circulars neglect to mention Ewart's other, more statistically defensible result; that thrips' treatment did not significantly effect the growth of young citrus trees.

Citrus entomologists Flaherty, Pehrson and Kennett note that, "In many cases treatments for thrips are overdone, with unwise choices of chemicals. In their zeal to protect their fruit, growers frequently resort to multiple treatments, some of which include combinations of insecticides. Often treatments are applied beyond the stage of fruit development susceptible to thrips' damage. Such treatment programs trigger biological upsets and promote resistance. Costly citrus red mite, brown soft scale, cottony cushion scale, or yellow scale treatments are the likely aftermath of thrips' control programs by multiple applications or combinations of insecticides."[84]

More research is needed to determine exactly the role citrus thrips' damage plays in the grading of fruit. If a realistic economic threshold level for thrips can be developed it must still be effectively communicated to growers by credible sources of pest control information. The difficulty with this approach is that the packing-house can instantly change the effective economic threshold for thrips' damage simply by changing the level at which it enforces this aspect of the quality standards. Furthermore, such a change is not readily detectable without constant, after the fact,monitoring of quality standards enforcement procedures. As long as growers are competing with each other to meet cosmetic quality standards they are running a risk in assuming an economic threshold level for citrus thrips greater than a few percent.

Sunkist states in regard to its quality standards that, "These rules and regulations are necessary, not only to preserve the legal rights of Sunkist Growers, Inc. in the Sunkist, Excel, SK and Red Ball trademarks, but to assure a continuing reputation of high quality which now attaches to them. This is the only way in which these famous trademarks can be used to derive the maximum benefits and returns for those marketing their fruit through Sunkist Growers, Inc. In adhering to these rules the strength and value of the trademarks will not only be maintained but will continue to increase."[85] Unfortunately, the current system of quality standard enforcement, which attempts to maximize the joint profits of growers, has negative social consequences. Some of the social costs can be enumerated in the case of citrus thrips.

As already indicated, the control of citrus thrips results in a cost of several million dollars annually to California citrus growers. The former widespread use of DDT for citrus thrips and later broad-spectrum organophosphate insecticides, has resulted in the elevation, to serious pest status, of a number of heretofore minor insects and mites. The most notable example of this phenomenon is the citrus red mite, Panonychus citri, which has become one of the leading citrus pests in California, in large part as a side-effect of citrus thrips treatment.[86,87]

This increase has paralleled the worldwide increase in the importance of spider mite problems as the use of synthetic organic insecticides has increased. This problem is highlighted by a recent issue (March, 1975) of Citrograph. This leading citrus industry journal contains a full page advertisement by American Cyanamid for its insecticide Cygon. The advertisement is headlined, "FOR THRIPS CONTROL--USE CYGON" and goes on to say, "When it comes to thrips on citrus, CYGON 267 Systemic Insecticide is outstanding. It's been doing a superior job on both bearing and non-bearing trees for many years and is now widely used for thrips and aphids." The generic name for Cygon is dimethoate. Dimethoate is an organophosphate insecticide which, according to von Rumker, is highly toxic to beneficial insects, including bees.[88]

In the same issue of Citrograph there is a full page advertisement for Dupont's Lannate. As a giant size cartoon thrips falls dead to the bottom of the page, the advertisement tells the reader, "This year, protect your trees—and harvest more scar-free fruit. See your pest control advisor and spray LANNATE this season." The generic name for Lannate is methomyl. Methomyl is a highly toxic carbamate which also adversely affects beneficial insects such as honey bees.[89] No mention is made in either of the advertisements of the possible adverse effects of using these insecticides, such as the induced outbreaks of citrus red mite and other serious pests. It is not known to what extent these advertisements affect grower pesticide use decisions, but they surely are a reflection of what American Cyanamid and Dupont salesmen are telling their client growers. Guthion, Phosphamidon and malathion are also highly destructive to *Amblyseius hibisci*, the predaceous mite that, in the past, has often kept the citrus red mite under effective biological control.[90]

The citrus red mite is one of the most expensive citrus pests treated. The estimated cost for citrus red mite control in 1974 was $4,427,322. The estimated loss of crop value, much of it attributable to cosmetic damage, was $6,049,014.[91] Citrus red mites are widely sprayed with chemical acaracides but the populations are rapidly becoming resistant to many of these chemicals.[92] One of the leading acaracides now in use is Kelthane, manufactured by Rohm and Haas. Kennett and Flaherty have pointed out that the citrus red mite has developed a moderate degree of resistance to Kelthane and as a consequence Kelthane is usually ineffective against the mite in the spring when populations are increasing at a rapid rate. On the other hand, the predator of the citrus red mite, *A. hibisci* has not developed resistance against Kelthane.[93] Rohm and Haas ran a two page, full color advertisement for Kelthane in the March, 1975 issue of *Citrograph* which features photographs of cosmetically perfect citrus fruit, but doesn't inform the reader of Kelthane's limitations as an effective acaracide.

As pesticide costs increase, the financial burden made necessary by quality standards for citrus thrips and the consequent resurgence of other pests, looms as a growing social cost to citrus growers as a whole, though as individuals they continue to strive to maximize their returns through the control of cosmetic insect pests.

The current level of control for thrips damage may constitute a threat to the welfare of farm workers. It is difficult to determine the exact amount of pesticides that are applied for the cosmetic control of citrus thrips, since the California Pesticide Use Report does not report pesticide use by pest category. The University of California and Sunkist recommendations list parathion, Delnav-dioxathion, guthion, phosphamidon, and dimethoate for the treatment of citrus thrips.[94] These are all organo-phosphates with high mammalian toxicities. The $3 million spent annually for citrus thrips control indicates that there is a substantial use of insecticides against this pest. According to the California Pesticide Use Report 23, 319 lbs. of Delnav-dioxathion, 35,580 lbs. of guthion, 16,581 lbs. of phosphamidon, 109,629 lbs. of dimethoate, 194,061 lbs. of parathion and 236,188 lbs. of malathion were sprayed on oranges in California in 1973.[95] Undoubtedly, a large amount of this material was used for the treatment of citrus thrips. Unfortunately, the California Pesticide Use Report does not classify pesticide use by target pest. An attempt to explore this question was made in the survey conducted by Norgaard. Unfortunately, the data on this question were sparse. The data that do exist and published pest control recommendations point to the use of organophosphates for thrips control. Growers and pest management consultants also indicate that organophosphates are often used in this manner, especially as the more selective botanical insecticide, such as Ryania and Sabadilla have become increasingly difficult to obtain.

We have dealt with the citrus thrips and its potential as a cosmetic pest in some detail. It should not be forgotten, however, that a number of the growers we spoke to also listed the citrus red mite and red scale as at least partially cosmetic pests. This is to say, there is some level of these pests which requires treatment, not because they have yet reached a density which constitutes a threat to the yield of fruit, internal fruit quality, or to tree vigor, but because the grower must meet cosmetic standards.

While at higher population levels, red scale and citrus red mite may be very serious non-cosmetic pests, the treatment for these pests at cosmetic levels may result in the same types of negative impacts that we have discussed in regard to citrus thrips. Moreover, it is possible that the same kind of effects that we have described for citrus thrips may occur in other crops that are marketed as fresh produce under strict cosmetic quality standards.

ALTERNATIVES AND OBSTACLES

There are several imaginable alternatives to the current situation regarding the citrus thrips' problem. These involve the changing of pest control practices, the changing of quality standards, or the changing of marketing practices, including consumer attitudes.

It may be possible to meet current quality standards regarding citrus thrips' damage with substantial reduction in the amount of pest control materials actually applied. As we have indicated, the available information suggests that an integrated control program, as opposed to an intensive chemical control program, results in a generally reduced application of insecticides as well as reduced over-all pest control costs. However, in regard to citrus thrips, the implementation of an effective integrated control program is problematical. Integrated control consultants would like to lower the status of citrus thrips in the pest hierarchy, or, what amounts to the same, to increase the economic threshold level for citrus thrips to some value greater than zero. If this could be accomplished the entire outlook for integrated pest management in oranges would be improved. As it is, there are two barriers to this policy. First of all, both the grower and the consultant may be uncertain as to the actual relationship between citrus thrips' damage and economic return. Additionally, the actual effective quality standards for citrus thrips, even if known with certainty, may be unreasonably high from an integrated pest management viewpoint. The overwhelming majority of growers market through marketing cooperatives, mainly Sunkist, that adhere to strict quality standards for thrips' damage. This difficulty could be resolved through the establishment of an explicit quality standard for citrus thrips' damage, a standard that takes the requirements of integrated pest management more into account.

Even under the current quality standards, integrated pest management consultants have sometimes been able to successfully tolerate a finite level of citrus thrips' damage. It has also been shown that citrus thrips can be partially managed through the use of cultural techniques and relatively non-disruptive insecticides. It is known that the presence of cover crops and the use of overhead sprinkler systems for irrigation greatly reduces the severity of citrus thrips' infestations, even to levels below a reasonable economic threshold. An experiment conducted in Tulare County between 1970 and 1972 demonstrated that citrus thrips can be effectively controlled through the use of such botanical insecticides as Ryania and Sabadilla rather than much more hazardous organo-phosphates.[96] Hopefully, a comprehensive and effective strategy for the integrated control of citrus thrips will eventually result from this research.[97] However, we should not lose sight of the current quality standards with regard to citrus thrips' damage which appear to constitute a barrier to the full development of an integrated pest management program for oranges as well as an integrated control program for citrus thrips itself.

Another alternative would be to simply not treat for thrips in mature groves except against infestations of such severity that tree vigor or yield is threatened. In the Fillmore Protection District only about ten percent of the acreage is treated for citrus thrips on the average.[98] If the level of enforcement of quality standards were relaxed even moderately it might be possible to eliminate the need for treatment against citrus thrips in this coastal growing area. According to many commentators, the primary obstacle to a change in quality standards is the attitude of consumers toward the cosmetic appearance of fruit. For example, W. Leland Brown, Agricultural Commissioner for Sacramento County comments: "Part of the problem is educating the consumer that just because a fruit is scarred with thrip (sic.) or whatever, doesn't mean that the interior quality is inferior. Oranges that are clean and perfect on the exterior just naturally sell better than oranges scarred by thrip (sic.) even though there is no difference in eating quality. But how do you convince the consumer of this?"[99] However, for the reasons already cited, it is not likely that consumer attitudes are the primary obstacle to altering existing quality standards. Consumer education campaigns can be successfully waged if somebody is willing to carry them out. The Consumer Cooperative in Berkeley, California, a major retail food outlet that is consumer owned and operated, recently featured cosmetically lower quality oranges, at 19¢ per pound as a "superior buy" over 29¢ per pound "Sunkist" oranges. This suggestion carried the prestige of the store's home economist.[100] Safeway Stores, on the other hand, recently ran an extensive television advertising campaign which featured Sunkist oranges and high-lighted the cosmetic aspect by showing grapefruit-sized oranges in Christmas stockings.[101] While Sunkist officials say that they give equal weight to taste and nutrition in their advertising,[102,103] it is far-fetched to think that Sunkist would risk its quality reputation by campaigning for cosmetically lower quality oranges.

Finally, it must be recognized that these suggestions deal with the problem in only a symptomatic manner. The unnecessary use of pesticides is but one of the social costs incurred as a result of a fundamental misallocation of agricultural resources and economic power and the short-sighted attempts to deal with these problems. It is not reasonable from an aggregate point of view, for the entire orange crop to be treated for optimal cosmetic appearance, when a large proportion of the crop ends up as juice and by-products. But, under the current system, for many growers, operating in isolation, seeking to maximize individual net return by maximizing the proportion of the crop that qualifies for the fresh market and the highest quality grade, means spraying the entire crop for full cosmetic effect, regardless of how much of the aggregate crop goes to juice and by-products.

REFERENCES

1. Gordon Rausser, "A Dynamic Econometric Model of the California-Arizona Orange Industry," Doctoral Dissertation, University of California, Davis, 1971, p. 1.
2. Walter Reuther, ed., THE CITRUS INDUSTRY, University of California, 1967, p. 80.
3. Reuther, op. cit., p. 69.
4. Reuther, op. cit., p. 139.
5. Sunkist Growers, Inc., CITRUS FRUIT INDUSTRY STATISTICAL BULLETIN, 1975, p. 12,13.
6. Reuther, op. cit., pp. 65-67.
7. James Youde, "Marketing Margins," CITROGRAPH, June, 1972, p. V.
8. John A. Jamison, "Marketing Orders and Public Policy for the Fruit and Vegetable Industries," FOOD RESEARCH INSTITUTE STUDIES IN AGRICULTURAL ECONOMICS, TRADE, AND DEVELOPMENT, Volume X, No. 3, 1971.
9. Reuther, op. cit., p. 66.
10. R. C. Rock and R. G. Platt, CALIFORNIA ORANGES, ACREAGE AND PRODUCTION TRENDS, COSTS AND RETURNS, Agricultural Extension, University of California, 1973, p. 1.
11. Rock, op. cit., Supplement.
12. Hoy Carman and James Youde, "Alternative Tax Treatment of Orchard Development Costs: Impacts on Producers, Middlemen, and Consumers," AMERICAN JOURNAL OF AGRICULTURAL ECONOMICS, Vol. 55, No. 2, May, 1973.
13. Hoy Carman, "Tax Loss Agricultural Investments After Tax Reform," AMERICAN JOURNAL OF AGRICULTURAL ECONOMICS, Vol. 54, No. 4, November, 1972.
14. Jeanne Dangerfield, "Sowing the Till", CONGRESSIONAL RECORD, May 16, 1973, Vol. 119, No. 74.

15. Between 1967 and August 1974 average weekly take-home wages as measured in 1967 dollars increased by less than 1% from $90.86 to $91.49 according to the Bureau of Labor Statistics.

16. CITRUS FRUITS, Statistical Reporting Service, United States Department of Agriculture, Washington, D. C., 1949-1974.

17. Rock, op. cit., p. 26.

18. FRUIT AND VEGETABLE INDUSTRY, National Commission on Food Marketing, Tech. Study No. 4. June, 1966.

19. Leon Garoian and Kirby Moulton, "Structure of the California-Arizona Market," CITROGRAPH, June 1972, p. VIII. p. 355.

20. Curtis Anderson, "Structure of Sunkist," CITROGRAPH, June, 1972, p. X.

21 U.S. Congress, House Committee on the Judiciary, Subcommittee of Monopolies and Commercial Law, Hearings, "Food Price Investigation," 93rd Congress, 1st Session, June, July 1973, Serial No. 15, p. 711-715.

22. Anderson, op. cit.

23. Linda Kravitz, WHO'S MINDING THE CO-OP?, Agribusiness Accountability Project, March, 1974, Washington, D. C. p. 47.

24. Anderson, op. cit.

25. Rausser, op. cit., p. 139.

26. Garoian, op. cit.

27. Federal Marketing Orders No. 907 and No. 908.

28. Garoian, op. cit.

29. F. M. Sherer, INDUSTRIAL PRICING, Rand McNally Publishing Co., Chicago, 1970, p. 3.

30. Kravitz, op. cit.

31. Garoian, op. cit.

32. Charles C. Teague, 10 TALKS ON CITRUS MARKETING, California Fruit Growers Exchange, Los Angeles, 1939, pp. 5, 16.

33. Robert Rock, "Marketing Orders," CITROGRAPH, June, 1972, p. VII. Also see Rausser for a complete discussion of orange marketing orders.

34. Federal Marketing Orders No. 907 and No. 908, FEDERAL REGISTER, December 30, 1961.

35. Stan Gillette, pers. comm., manager of Euclid Pure Gold packing-house, pers. comm., October, 1974.

36. Federal Marketing Orders No. 907 and No. 908.

37. Rock, op. cit., June, 1972.

38. For an analogous situation in cling peaches see Jamison, p. 298.

39. Floyd D. Shimomura, "A New Look at the California Marketing Act of 1937,"

40. Tom Karins, grower, pers. comm., Exeter, California, October, 1974.

41. Robert Howie, pers. comm., August 6, 1974.

42. Shimomura, op. cit., p. 191.

43. California Food and Agricultural Code, Sections 46951-46961.

44. David Pimentel, "Extent of Pesticide Use, Food Supply, and Pollution," NEW YORK ENTOMOLOGICAL SOCIETY, March, 1973, p. 21.

45. George, op. cit., p. 74.

46. Everett J. Dietrick, Rincon-Vitova Insectaries, Inc., pers. comm., August 19, 1974.

47. Rausser, op. cit.

48. Irving L. Eaks, "Rind Disorders of Oranges and Lemons in California," in H. D. Chapman, ed., PROCEEDINGS OF THE FIRST INTERNATIONAL CITRUS SYMPOSIUM, University of California, Riverside, March, 1969, p. 1343.

49. Interview with Sunkist, Pure Gold, and ICCAP representatives, pers. comm., September 24, 1974.

50. Garoian, *op*. *cit*., p. IX.

51. Of nine orange growers interviewed, all nine stated that the enforcement of quality standards was adjusted intraseasonally.

52. Richard Breuner, pers. comm., August 6, 1974.

53. Don Avis, pers. comm., August 11, 1974.

54. N. G. Hardy, "New Citrus Committees Study Ways to Improve Quality, Increase Sales," *The Produce News*, Sept. 11, 1976.

55. Pimentel, *op*. *cit*., p. 15.

56. PESTICIDE USE REPORT BY COMMODITY, 1973, State of California Department of Food and Agriculture, Agricultural Chemicals and Feed, Sacramento, 1974, pp. 170-175.

57. Don Avis, pers. comm., October 14, 1974.

58. According to data provided by Norgaard, see note 67, below.

59. Reuther, *op*. *cit*., p. 81.

60. INTEGRATED PEST MANAGEMENT PROGRESS REPORT, Volume 1, September, 1974, p. 87.

61. C. E. Kennett, citrus entomologist, University of California, Berkeley, pers. comm.

62. C. B. Huffaker, "The Ecology of Pesticide Interference with Insect Populations," in AGRICULTURAL CHEMICALS--HARMONY OR DISCORD FOR FOOD, PEOPLE AND THE ENVIRONMENT, John E. Swift, ed., University of California, 1971, p. 99.

63. C. E. Kennett, personal communication.

64. Reported in Ray Smith, "What is Being Done by the Universities," in AGRICULTURAL CHEMICALS--HARMONY OR DISCORD, p. 141.

65. As part of a study on pest management technology, for the Ford Foundation, W. Willey and R. Norgaard have surveyed growers on their attitudes toward integrated and conventional pest management and have collected objective data on growers who have and have not adopted independent pest management consultants. The data on orange growers has been made available to us and we report some of our observations on these data.

66. R. C. Hall, R. Norgaard and P. True, "The Performance and Independent Pest Management Consultants in San Joaquin Cotton and Citrus, California Agriculture, October, 1975, p. 12.

67. Howard B. Lorbeer, FIFTY SECOND ANNUAL REPORT, FILLMORE CITRUS PROTECTION DISTRICT, December 31, 1973.

68. A survey of nine California citrus growers, six located in the Central California growing region and three in the Desert region.

69. J. R. Horton, "The Citrus Thrips," United States Department of Agriculture Bulletin No. 616, February 14, 1918, Washington, D. C.

70. Stanley F. Bailey, "Thrips of Economic Importance in California," Circular 346, University of California Agricultural Experiment Station, Berkeley, December, 1938, pp. 39-44.

71. Ronald Hawthorne, "Estimated Damage and Crop Loss Caused by Insect/Mite Pests, 1974," California Department of Agriculture, Sacramento, September 4, 1974.

72. D. L. Flaherty, J. E. Pehrson and C. E. Kennett, "Citrus Pest Management Studies in Tulare County," CALIFORNIA AGRICULTURE, November, 1973, p. 4.

73. G. E. Carman, et al. "1974-1975 Treatment Guide for California Citrus Crops," University of California Agricultural Experiment Station, Riverside, 1974, p. 31.

74. Dick Lyneis, "If You Rule Out Pesticide Use, You May Have to Eat Worms," THE PRESS, Riverside, June 3, 1971.

75. Anonymous, SUNKIST CITRUS DEFECTS MARKET HANDBOOK, Sunkist Growers, Inc. 1974.

76. Don Avis, pers. comm., August 11, 1974.

77. William K. Quarles, pers. comm., December 19, 1974.

78. W. H. Ewart, H. S. Elmer and O. L. Browner, "Effects of Citrus Thrips Populations on Navel Orange Fruit Yield and Tree Growth in Central Valley" *Citrograph*, November, 1975, p. 9.

79. W. N. Ewart, pers. comm., October 15, 1976.
80. T. F. Leigh, pers. comm., February 11, 1977.
81. Cost estimates and yield estimates provided by citrus entomologist, C. E. Kennett, pers. comm., October 26, 1976.

82. Don Avis, *Sunkist Pest Control Circular*, February, 1974, 1975.

83. Don Avis, *Sunkist Pest Control Circular*, March, 1976.

84. Flaherty, *op. cit.*, p. 4.

85. "Rules and Regulations Governing Fruit Packed For Marketing by Sunkist Growers, Inc. Under its Trademarks Sunkist, Excel, Sk, and Red Ball and Under Association Non-Advertised Brands," Sunkist Growers, Inc., November 1, 1967.

86. C. E. Kennett and D. L. Flaherty, "Spider Mites," San Joaquin Valley Agricultural Research and Extension Center, Parlier, September, 1974.

87. R. F. Luck, R. van den Bosch, and R. Garcia, "Chemical Insect Control, A Troubled Pest Management Strategy," to be submitted to *BioScience*, 1975.

88. R. M. von Rumker, PESTICIDE MANUAL, RvR Consultants, Shawnee Mission, Kansas, August, 1972, p. 234.

89. E. C. Loomis and W. Stengor, "Environmental Impact of Pesticides. Insects, Mites, and other Invertebrates, Univ. of Calif., Div. Agric. Sci., 1972, p. 113.

90. Kennett, op. cit., September, 1974, p. 20.

91. Hawthorne, op. cit.

92. George P. Georghiou, "Resistance of Insects and Mites to Insecticides and Acaracides and the Future of Pesticide Chemicals," in AGRICULTURAL CHEMICALS--HARMONY OR DISCORD, p. 118.

93. Kennett, op. cit., September 1974, pp. 20, 26.

94. "Treatment Guide for California Citrus Crops," p. 31.

95. PESTICIDE USE REPORT, 1973, p. 170-175.

96. Flaherty, op. cit., p. 5.

97. IPM PROGRESS REPORT, 1974.

98. Lorbeer, op. cit.

99. W. Leland Brown, pers. comm., August, 1974.

100. Observed at the Berkeley Co-op, December 17, 1974.

101. Observed on Bay Area television and Safeway Stores, December, 1974.

102. Quarles, op. cit.

103. Sunkist representatives, pers. comm., September 24, 1974.

CHAPTER 4. COSMETIC QUALITY STANDARDS AND PESTICIDE USAGE IN PROCESSING TOMATOES AND CLING PEACHES

The conditions under which this investigation was conducted did not permit as thorough an assessment of the produce cosmetic quality-pesticide usage relationship in processing tomatoes and cling peaches as was done for fresh market oranges. However, sufficient information was gathered to indicate that the pressures, which force the orange grower to produce "impeccable" produce, also bear upon the tomato and cling peach grower. Taken together the three crop studies appear to set a pattern which probably applies to many other types of agricultural produce.

PROCESSING TOMATOES

TOMATO PRODUCTION

California leads the nation in the production of tomatoes. In 1974 83 percent of the nation's supply of processing tomatoes (4.8 million tons) were produced in California.[1] Along with Florida, California is the leading producer of fresh tomatoes, each state supplying about 25 to 30 percent of the national need. The production of fresh and processing tomatoes are each very specialized activities; they are essentially different crops. Therefore, this discussion will be restricted to processing tomatoes.

Processing tomatoes are not grown throughout the state but are concentrated in certain geographical sections. Eighteen of California's 58 counties produce processing tomatoes, with the mid-Central Valley counties of Yolo, Fresno, San Joaquin, Sutter, Solano and Sacramento being the major producers. Yolo County leads the state with a 1972 production of one million tons, about one-sixth of the national total production.[2] The harvested acreage for the processing tomatoes in California has fluctuated significantly from year to year. For example the harvested acreage declined from 231,000 acres in 1968 to 141,000 acres in 1970, but since 1970 acreage has been steadily increasing at about 15,000 to 30,000 acres per year. The overall trend in harvested acreage for the state has been increasing in the post World War II period. On the other hand, for the United States, as a whole there has been a declining trend from the peak harvest year of 1946 of some 570,000 acres, to the 1973 harvest of 300,000 acres. The yield per acre in California processing tomatoes has doubled in this same period to its present level of about 24 tons per acre.[3] There has been a sharp decline in the number of processing tomato growers in California, from about 4000 growers in 1964 to just over 600 in 1973.[4]

With the reduction in the number of processing tomato growers in California from 4,000 in 1962 to about 600 in 1973,[5] it might be thought that an effective bargaining association would develop among tomato growers. However, this does not appear to be the case, at least to date. With several hundred processing tomato growers, without an effective grower bargaining association, facing only a handful of processing firms, it might be expected that the market is monopsonistic, with the bargaining power centered in the processing firms. But, Chern presents some econometric evidence which suggests that the market is competitive with respect to the price paid for processing tomatoes.[6] This does not eliminate the possibility that the processing firms may utilize the quality standard provisions of processor-grower contracts to their advantage. Statements from the California Tomato Growers Association do not indicate that to date, the Association has been able to muster any significant bargaining power. In March of 1976, the Association accepted a contract with Hunt & Wesson, the price leader, for $47 per ton of tomatoes, down 12% from 1975.[7] California Tomato Growers Association President, Jack Hayes, urged tomato growers to reduce acreage by 20% from the 299,200 acres planted in 1976.[8] However, if the lower price fails to result in this substantial reduction in tomato acreage, the Association has no formal method of enforcing or coordinating such a reduction among its members.

Lower product price may not, in itself, result in the optimal decrease in planted acreage for the following reason, according to agricultural economists Doll, Rhodes and West:[9]

> As the total output of a particular farm product increases, prices received by producers decline. What started out as individual decisions to increase output on individual units has consequences for the group. An important aspect of the situation is that the decision with respect to the level of production is made prior to the time the product is ready to sell. In many cases this may be several months or even in a few cases many years prior to the time the product is sold. Research related to individual decision making with respect to level of output has shown that decisions are based on current price or the price which has existed in some recent past period. The level of individual farm output may or may not be the optimum one if price changes during the production period. However, assume for the moment that the individual farmer is well aware of the fact that if he and other individual farmers increase output prices will decline. Will he as an individual find it desirable to restrain his increase in output? Only if he can be assured that others will act in a similar way -- an assurance he does not have!

USE ALLOCATION OF PROCESSING TOMATOES

In 1960, the latest year in which complete comparative data are available, the California processing tomato crop was allocated to the following uses:[10]

Canned Tomatoes	212,000 tons
Tomato Juice	211,000 tons
Chili Sauce	25,000 tons
Tomato Puree	142,000 tons
Tomato Products	50,000 tons
Tomato Catsup	367,000 tons
Tomato Paste	801,000 tons
Tomato Sauce	414,000 tons

According to Mel Zobel, Farm Advisor in Yolo County California, processing tomatoes are not distinguished by use until after they have been acquired by the processor, thus all processing tomatoes must meet the same quality standards, even though, according to Zobel, it is impossible for the consumer to detect insect parts or insect damage in the ground-up tomato products, such as tomato paste, sauce, puree, and catsup.[11] As indicated above, the presence of insects of field origin in these products has not been known to cause a health hazard.

QUALITY STANDARDS FOR PROCESSING TOMATOES

Tomato is one of the few crops in which there is a state quality standard which refers explicitly to the product meant for processing. Until 1968 the state quality standards for processing tomatoes allowed up to 10 percent worm damage. However, the provision was amended in 1968 to restrict worm damage to 2 percent.[12]

Processor contracts generally do not allow more than one percent worm damage, and in fact many contracts allow the buyer to reject shipments which contain in excess of 1/2 percent worm damage, and, in some cases, the buyer may require zero worm damage. The effect, in all these cases, is for the grower to feel that his tomatoes must have a zero level for worm damage, if he is to avoid the risk of rejection of his crop at the cannery. As one grower explained,

> Standards for insect parts and damage can be graded. It is the idea of establishing standards that are designed to eliminate ALL insects that cause fear to develop in the mind of the farmer.
>
> We were under scheduled treatments and most of them are bought out of fear of very low tolerances established by processors through contracts.

> Further reductions in pesticide usage could be obtained if there weren't the fear of the zero tolerance for insect parts.
>
> I know we never would have to spray tomatoes if the rumor weren't to have zero tolerances on worms. Russet mite is sprayed for only in unusual situations, usually after treating for worms.

In addition to contractual obligations tomato processor pressure growers who deviate from an intensive spray program. One processor representative sent the following letter to a tomato grower who was attempting integrated control:

> The 1971 tomato crop is in the process of being planted and, although we have had cool weather, the crop is approximately three-fourths emerged. The early acreage is progressing at a rather slow rate but appears to have a satisfactory stand.
>
> I am again making it my responsibility to remind you that a continued emphasis on quality of raw product with special attention to insect contamination, is mandatory if California tomato products are to maintain their high quality reputation and market acceptance.
>
> The company intend to protect their operations during the coming harvest season by giving very close scrutiny to any or all your loads where "State Inspection" has indicated a measurable amount of worm contamination. If contamination is confirmed by our own inspection, such loads may have to be returned to you. Presentation of two consectuive loads containing 1% or more of worm contamination may result in condemnation of the remainder of the field involved.

Later in the season the processor representative wrote:

> It would look like we will have a full schedule for the month of August and the early part of September; therefore, I recommend that a twice-weekly inspection of all of the tomato fields be carried out and a vigorous insect prevention program be in effect at all times. We do not want insect contaminated tomatoes (emphasis in the original)

Obviously, growers who receive letters of this kind are likely to be very apprehensive about having worms of "a measurable amount". A "vigorous insect prevention program...in effect at all times" can only refer to prophylactic spraying for worms whether they are present or not.

PEST MANAGEMENT FOR PROCESSING TOMATOES

The major insect pests in processing tomatoes are such Lepidopterous larvae as the tomato fruit worm, cabbage looper, armyworms, pinworm, and tomato hornworm. Russet mite, flea beetle, darkling ground beetle and aphids are also commonly found attacking tomatoes. Integrated pest management and conventional chemical control depend on similar chemical materials, with the exception that certain broad-spectrum cehmicals are avoided under integrated pest management. However, under integrated pest management there are generally fewer applications of the chemicals, lower dosages of the chemicals used, and an avoidance of combination applications.

In a recent study conducted by the Association of Applied Insect Ecologists in collaboration with Dr. Charles Summers of the University of California, Berkeley, the effectiveness of conventional chemical control and integrated pest management, programs in processing tomatoes were compared. Twenty-four fields were divided into two groups, twelve under conventional control and twelve under integrated control. Reports of every chemical application and the reason for it were requested. Frequently an insecticide was applied because the grower "felt like it". At the time of a fungicide application often an insecticide was added for good measure. Summers reported that approximately 30 percent of the insecticides were applied as fungicide/insecticide combinations.

The research team members did their own grading which was repeated by state inspectors. None of the loads were rejected. Statistical analyses revealed that there was no difference in yield or insect damage between the integrated pest management and the conventional chemical control fields. At one point in the study, when the integrated fields had received one treatment and the conventional fields three, a group of cannery representatives and growers were asked to compare two fields in the Lodi area; they could detect no differences between the conventionally controlled field and that under integrated pest management.

Overall the integrated pest management fields received 58 percent less insecticides than the conventional chemical control fields. The integrated control fields received between zero and three applications while the conventional fields received between two and four applications. The pest management cost per acre was significantly lower for the integrated control fields than the conventional fields.[13] Historically several privately practicing pest control advisors have provided excellent tomato pest control for California growers under integrated control programs which utilized substantially less pesticide than conventional programs.[14]

The indications, then, are that current quality standards for processing tomatoes can be met with a significant reduction in pesticide use. However, as we have indicated above (see page 111), implied zero tolerance cosmetic quality or insect contamination standards form an obstacle to grower acceptance of integrated pest management. Furthermore, relaxation of pest "injury" levels for processing tomatoes would allow for an additional reduction in pesticide use. According to Zobel, two-thirds of the current pesticide use in processing tomatoes is for the tomato fruit worm "control".[15] Under prevailing standards there is a strong probability that the bulk of this treatment is essentially for cosmetic purposes and not because of substantial threat to crop yield, quality or wholesomeness. In 1973, 89,928 pounds of parathion was sprayed on 113,610 acres of tomatoes in California, according to the California State Department of Agriculture Pesticide Use Report. In addition 163,439 pounds of Methomyl (Lannate) and

256,488 pounds of Carbaryl (Sevin) were used.[16] These pesticides are often used in the treatment of worms on tomatoes.[17]

There seems to be no compelling reason why the cosmetic quality and insect contaminant standards in processing tomatoes should be as stringent as they currently are, especially in the majority of cases where the tolerance for isnect parts or damage approaches the zero level. For example, more appropriate worm damage standard would perhaps be the current state standard of 2 percent for processing tomatoes. It seems reasonable that quality standards could be less stringent for the high percentage of tomatoes that are allocated to such products as paste, puree and catsup if some more rational allocation method could be designed. In order for there to be a relaxation of quality standards for processing tomatoes the federal FDA regulations for insect parts debris would have to be clarified so that these regulations could not be used, by the processors as a justification for demanding stringent cosmetic quality standards for raw produce at the input end of processing. As indicated above, the future adjustment of quality standards for processing tomatoes may also depend in part on the growers who, quite ironically, may be developing a stronger position vis-a-vis the processors as their (the growers) numbers diminish. Whether this stronger bargaining organization evolves, and if so, whether the growers place high priority on modifying quality standards, remains to be seen.

CLING PEACHES

Virtually all cling peach production takes place in California. In 1974, 51,705 acres of California agricultural land was devoted to cling peach orchards, producing a yield of 791,856 tons.[18] Cling peaches are used exclusively as an input to the canned fruit industry, along with apricots, bartlett pears and freestone peaches. Cling peach is the predominating commodity in California canned fruit industry accounting, in 1969, for about 60 percent of the input in terms of tonnage and 54 percent in terms of cash value to growers.[19]

ACREAGE AND PRODUCTION

Cling peach acreage, as well as production, increased throughout the 1960's only to take a precipitous decline in the last few years. The number of cling peach growers and canners declined significantly in the 1960's. Between 1960 and 1968 the number of cling peach growers decreased from about 2,800 to about 2,200, while the number of cling peach canners declined from 38 to 17.[20]

THE CLING PEACH MARKETING ORDERS

These historical trends are, in part, a result of the operation of the cling peach marketing orders. Cling peach growers and canners have been under the control of state marketing orders since the early 1930's. The cling peach marketing orders have been the most comprehensive and complex of any, and have certainly resulted in the most heroic attempts at commodity quantity control.[21]

SURPLUS ELIMINATION

Until recently, the cling peach marketing orders contained a number of provisions for the elimination of "surplus" fruit both by the producers and processors. If the cling peach marketing board determined that a "general surplus" exists, that the producers aggregate capacity to produce peaches exceeded the needs of the canning industry with consideration for excess tonnage to assure an adequate supply in the case of adverse weather or growing conditions, then individual growers had the option of eliminating up to 108 bearing trees per acre from their orchards. As an incentive for such tree elimination the grower was granted credits for trees removed against any seasonal surplus elimination that required mandatory elimination by green drop or tree elimination. By May 15 of each year, when the fruit reached a degree of maturity that makes an accurate estimate of the final yield possible, the crop was again evaluated to determine whether a "seasonal surplus" existed. If the board determined that a seasonal surplus did exist it could recommend to the State Director of Agriculture that an order be issued which required each and every peach grower in California to eliminate a specified percentage of his crop by green drop or by tree elimination. Green drop required the removal of all peaches from a specified number of trees in the orchard. As an alternative the grower could remove an equivalent number of bearing trees or apply credits for bearing trees removed under the general surplus provisions.

Surplus diversion could also take place at the cannery. Immediately prior to harvest the cling peach marketing order board reviewed its earlier estimates of crop tonnage available in relation to market requirements. If a surplus was found to exist at this point, it recommended to the Director of Agriculture that each processor be required to divert a quantity of Number 1 cling peaches from normal processing during the season. The amount diverted could not exceed 7 percent of the quantity of Number 1 cling peaches available for processing.[22]

QUALITY PROVISIONS

The cling peach marketing orders also contained provisions in regard to quality standards. These are listed in Table 1. As we have indicated above there are no state statutory standards that are applicable to peaches used as an input to processing. The state quality standards for fresh (freestone) peaches are concise and rather conservative. The definition of insect damage is rather vague, including injury "which has penetrated or damaged the flesh." The tolerance for insect damage is 5 percent, or 7 1/2 percent if damage due to all causes is less than 10 percent.

The cling peach marketing order sets quality standards for Number 1 cling peaches, the grade that fruit must meet in order to be acceptable for processing. The quality provisions in the marketing order are much more detailed than the state quality standards for fresh peaches and, in addition, the marketing order contains some types of quality provisions that are absent from the state quality standards for fresh peaches, most notably size standards.

In addition to these marketing order quality standards, the contractual agreement between processors and producers further reduces the tolerances for brown rot and worms or worm damage to 2 percent and 1 percent respectively.[23]

The general cosmetic nature of these provisions is evidenced by the fact that, under the provisions of the marketing order, the processor could divert off-grade peaches or an equivalent amount of Number 1 peaches from production. That is, once the percentage of off-grade peaches was established by inspection of a random sample, the processor could simply divert that percentage of peaches from processing, regardless of the quality of the individual peaches diverted. The remaining peaches, which could include a percentage of off-grade fruit, was then processed. The producer, of course, was not paid for the peaches "culled out" in this manner. It is possible for the canners to process off-grade peaches because, in most cases, the "injury" is eliminated along with the skin when the peaches are boiled in lye.[24]

According to Jamison the quality standards for Number 1 cling peaches have increased in their specificity in successive marketing orders.[25] The green drop and tree removal provisions were used heavily and, the extremely heavy use of tree elimination in 1969, 1970 and 1971 resulted in a 26 percent reduction in cling peach acreage and a 31 percent reduction in cling peach production between 1969 and 1972.[26] In his study on the cling peach marketing orders Jamison explains this history in the following way. Operations of the cling peach marketing orders resulted in short-run increases in net returns to the grower. But this results in a period of rapid expansion in the production sector. As Jamison comments,[27]

> Monopoly pricing is, by definition, impossible in industries where entry is not highly restricted. Where this is recognized in agriculture attempts have been and are still made to block new entrants. These attempts have proven fruitless because the necessary condition of internal homgeneity within the monopoly-seeking group of farmers has never existed. Producers who achieve rewarding net returns under cartel-like conditions have not long been content to subsidize their less profitable neighbors by restricting their own production. Nor will the profitable members of the cartel be willing to erect entry barriers which may also limit their own expansion. Under these conditions, monopoly pricing is an impossible long-run goal in agriculture, and the pursuit of the structural conditions which are required to achieve it is windmill-tilting in the extreme.

The same factor which draws a disproportionate amount of new resources into the production of cling peaches, the artifically maintained price of the crop also results in a contraction of the processing sector. If canners pass the higher price of their raw produce on to the consumer they face a fall in demand and, consequently, a profit squeeze; if canners absorb the increased cost of the cling peaches they also face a profit squeeze. Thus, in the same period that the cling peach production sector was undergoing price induced expansion, the cling peach processing sector was undergoing contraction. The gap was partially filled by an expansion of grower-owned cooperative canneries. However, it was also found necessary to exert progressively more stringent marketing order controls culminating in the 1969-71 period with a massive tree elimination program.[28]

In evaluating the social cost of the cling peach marketing order Jamison includes the cost of eliminated trees, of green dropped fruit, of cannery diverted fruit, of artifically high consumer prices, and of agricultural resources allocated inappropriately to the production of cling peaches. Jamison concludes,

> Not only have resources spent in cling peach production risen to levels far in excess of those suggested by market demand, but the producers themselves are being assessed continually higher costs as the burden of carrying this excess capacity. In addition, while maintaining in production uneconomic orchards and inefficient producers the cling peach industry continues to attract new entrants who can operate profitably under the costly control programs and relatively stable price levels that have been maintained. This new capital investment increases the surplus burden, and, more importantly, it further exaggerates the misallocation of total resources within the economy. Because of this the consuming public loses two ways--by prices higher than justified by total resources allocated to cling peaches production and by the necessity of depriving other more desired production activities of these resources .... One additional repercussion of the crop restriction pursued by the cling peach industry relates to its effects on the total income generated by the product as it moves to the consumer. For example on the basis of (postulated price elasticities) the increase in total revenue to producers resulting from a reduction in the pack from 30 million to 24 million cases is $7.5 million. This pack reduction decreases revenue at the processor level by $15 million and at the retail level by $27 million. In other words, maintenance of the original level of production at the grower level would result in a total revenue generation of $210 million compared to $183 million at the quantity suggested by unit elasticity at the grower level. This could be

> interpreted as a loss of jobs in the marketing as well as the supplying industries. At the same time the retail cost of the product to consumers is raised from $7.00 per case (29¢ per 2 1/2 size can) to $7.60 per case (32¢ per can). The costs of restrictionism of this type are clear. Even the cling peach growers, the only possible beneficiaries of the scheme, have eventually lost due to the apparent necessity of eliminating 25 percent of their production in 1970 and an even greater share in 1971.[29]

To these costs must be added the increased cost of growing cling peaches as individual growers, striving to increase yields in order to beat back the losses due to increased quality standards and cull out rates, utilize inputs, including pesticides, in a more intensive manner. Additionally, under these conditions there is an irresistable temptation for canners to attempt to increase their supply of cling peaches and reduce the price of this supply through the utilization of qualfty standards. The grower has an equal tendancy to attempt to meet the most stringent quality standards, in order to maintain the full maintained price of his produce. Of course, he has an added incentive to maintain quality in regard to the standards for worms or worm damage, since the entire shipment can be rejected on failure to meet this standard. Growers may even resort to expensive and time-consuming hand-culling at the ranch in order to insure that no worm damage is present in their crop. Effective pest management, through chemical or other means would obviously be preferred by the grower.

Finally the increasing production of cling peaches at an artifically maintained price, coupled with the decreasing capacity of canning plant facilities, has aggravated the problem inherent in matching the time flow of harvested peaches with the plant capacity of canneries. This problem is illustrated in figure 7. Because of a constant plant capacity but a seasonal variation in cling peaches harvested, if the canning industry is to run anywhere near full capacity for most of the season it will face an over-capacity situation--an over-supply of peaches--for at least part of the season. The cling peach industry is currently giving consideration to the development of and distribution of cling peach varieties that would result in a smoother seasonal yield pattern, but such a program may take a very long time to implement. In the meantime, canners find it to their advantage to invoke quality standards, during the surplus part of the season, in order to reject the surplus cling peaches on the market. The severe quality standards for worms and brown rot that are often incorporated into standard cannery-producer contract, or are included in "dirty riders" to the standard contracts allow for this to happen. This is the reason why the quality standards specified in individual processor-producer contracts are more severe than the quality standards spelled out by the industry-wide marketing order. Growers would like individual contracts to coincide with the marketing order but have not been totally successful on this score.[30]

Various attempts have been made, in recent years, by cling peach growers to alleviate the negative aspects of the cling peach marketing order. In 1971 the California Canning Peach Association, a grower's bargaining cooperative, backed state legislation which would have allowed growers to vote on the desirability of acreage limitation. This bill passed the state legislature but was vetoed by the Governor. The Association has bargained for long-term contracts with processors.

Since 1975 the surplus elimination provisions have been excluded from the cling peach marketing order.[31] The California Canning Peach Association has attempted to constitute itself the exclusive bargaining cooperative for the industry and thereby replace the surplus elimination provisions of the marketing order with a combination of free market regulation and grower discipline. However, the Association has not been successful in achieving this goal to date. In 1976 the Association settled on a price of $115 per ton for cling peaches, down 10.5% from the 1975 price.[32] Before the cannery strike of 1976 there were 100,000 tons of cling peaches in surplus, and the Association was asking for reinstatement of cannery diversion.[33] California Canning Peach Association President, Ron Schuler stated that, "The larger stocks of canned fruit on hand and prospects for a good harvest and large crops in 1976 have put a stress on the association's ability to bargain for a price."[34] Thus, the forces which make quality standards a critical determinant in the economic survival of cling peach growers do not seem to be at an end.

PEST MANAGEMENT IN CLING PEACHES

The major pests in California cling peaches are the Oriental fruit moth, *Grapholitha molesta* (Busck), the peach twig borer, *Anarsia lineatella* Zeller, and several mites: the two-spotted spider mite, *Tetranychus urticae* Koch, the European red mite, *Panonychus ulmi* (Koch) and the peach silver mite *Aculus cornutus* (Banks). Other pests that can cause trouble include San Jose scale, Coryneum blight (Shot hole), thrips, lygus, the consperse stink bug, the western peach tree borer, the fruit tree mite and the flat-headed borer.[35] Damage attributable to the Oriental fruit moth and the peach twig borer is summarized below:[36]

	ORIENTAL FRUIT MOTH		PEACH TWIG BORER	
YEAR	YIELD LOSS	CONTROL COSTS	YIELD LOSS	CONTROL COSTS
1970	$1,261,804	$2,172,979	$1,840,827	$3,027,282
1974	$2,154,950	$2,100,340	$5,449,737	$6,157,599

Source: Ronald Hawthorne, California State Survey Entomologist

Under conventional control programs these two pests have been treated heavily with organophosphate and carbamate insecticides. In 1974 California peach growers sprayed 54,675 acres with 71,704 pounds of Guthion and 40,664 acres with 70,059 pounds of parathion. This practice has resulted in the evolution, to serious pest status, of the phytophagous mites. For example, California peach growers sprayed 15,079 acres with 25,895 pounds of the acaracide Omite in 1974.[37] In 1974, pest control costs for cling peaches were $154/acre out of total production costs of $701.19.[38]

A preliminary integrated pest management program for cling peaches has been developed which is designed to take advantage of the natural controls already present in the system through a program of careful monitoring of insect and mite population levels and the selective use of pesticides. The predacious mite Metaseiulus occidentalis which is commonly present in cling peach orchards, is an effective predator of the two-spotted spider mite and the European red mite. However, under conventional control this beneficial mite is often suppressed by the imprudent application of organophosphates and carbamates. The peach silver mite is an important secondary food source for M. occidentalis, thus if the peach silver mite is eliminated with acaracides, the population of M. occidentalis will starve, very few will overwinter, and an inadequate population will be present in the spring to control the population of the two-spotted spider mite and the European red mite. Based on this knowledge, L. E. Caltagirone, of the University of California's Division of Biological Control, Albany, has devised the following integrated pest management program for cling peaches:[39]

(1) Control of peach twig borer, San Jose scale, and mites (partially) with a dormant spray.

(2) Elimination of the early spring spray.

(3) Control of Oriental fruit moth, timing the treatments very carefully; two sprays during the season may be sufficient.

(4) Reduction or elimination of the sprays to control two-spotted spider mite and European red mite, if there are enough predators, treatments are not necessary.

(5) Limitation of the treatments against peach silver mite to the absolute minimum; very few cases, if any at all should require spraying.

Caltagirone comments that the importance of the peach silver mite as a pest has been overestimated by growers. Additionally, he comments in regard to the Oriental fruit moth and peach twig borer that,

> The economic injury level in terms of population density for these two species has not been established. Tolerable damage to fruits may be somewhere between zero and four percent. Some growers, and probably most if not all canners, feel that no amount of worm damage to fruits should be tolerated. Apparently, damage to twigs is of little importance in bearing trees. So, this gives some idea of how much damage we can accept. But there is another dimension to the problem. In order to implement a modified pest control program, it is necessary to predict the extent of damage that a given early season population will eventually cause, so the tactics can be modified, if necessary, without endangering either the crop or the program.[40]

This critical aspect of the integrated pest management program for cling peaches is extremely sensitive to the specification of quality standards and, as we indicate below, has been adversely affected by recent modifications in the quality standards.

COSMETIC QUALITY STANDARDS AND PESTICIDE USE IN CLING PEACHES

In private communications,[41] an independent pest management consultant who manages a substantial acreage and is familiar with both conventional chemical control and integrated pest management in cling peaches indicated that among the pests Lygus and thrips cause cosmetic injury only and must be treated simply to meet quality standards. Furthermore, the 1st brood of peach twig borer and Oriental fruit moth cause only superficial (cosmetic) damage that is removed with the peach skin in the processing procedure. Mildew is superficial on fruit and is removed during processing. Coryneum blight (Shot hole) must be controlled in the dormant season but an extra spray to protect the fruit from Shot hole will only prevent superficial injury which presently results in the fruit being culled. San Jose scale can be very harmful to the tree vigor by virtue of its feeding on twigs and limbs but the fruit feeding is not evident after the skin is removed in processing.

According to this same pest management consultant the quality standard for worms (peach twig borer and Oriental fruit moth) has undergone important modifications in the last few years. In the past fruit injury could only be classified as worm damage if associated larvae were present in the lot of fruit. Under the new procedure the presence of larvae is not required. The effect of this is to make it necessary to treat the fruit to prevent superficial damage caused by the 1st and 2nd broods of Oriental fruit moth and peach twig borer, which feed only superficially on the green fruit. The consequential early season spraying with organophosphates and carbamates disrupts the entire integrated pest management strategy. The natural enemies of mites are suppressed and it becomes necessary to treat for these pests with expensive acaracides. The situation is further aggravated because in most cases the mites develop resistance to the acaracide within two or three seasons.

Thus, in this case, the effect of strict enforcement of cosmetic quality standards is to force the abandoment of a well-developing and promising integrated pest management program with resultant increases in pesticide use and further disruption of the peach agro-ecosystem. Moreover, the motive for strict enforcement of cosmetic quality standards, in this case, is totally unrelated to consumer preference, or to crop yield or vigor; rather, it is a side-produce of the continuing economic struggle between the interest of peach growers and processors, a side-product whose negative social impacts are not well taken into account by the current economic mechanism that determines how cling peaches are to be produced.

Cosmetic Quality Standards and Pesticide Usage in Processing Tomatoes and Cling Peaches--Footnotes

1. Wen S. Chern, "Acreage Response and Demand for Processing Tomatoes in California," *American Journal of Agricultural Economics*, May, 1976, p. 209.
2. Gordon A. King, Edward V. Jesse and Ben C. French, *Economic Trends in the Processing Tomato Industry*, University of California Extension Service, August 23, 1973.
3. King, *op. cit*.
4. William H. Friedland, Amy Barton and Robert Thomas, "De-stalking the Wily Tomato," University of California, Santa Cruz, 1976, p. 18.
5. Chern, *op. cit*.
6. Anonymous, *Pacific Fruit News*, March 27, 1976.
7. Anonymous, *Western Packing News*, February 16, 1976.
8. J. P. Doll, V. J. Rhodes, and J. G. West, *Economics of Agricultural Production, Markets, and Policy*, Richard D. Irwin, Inc., 1968, p. 472.
9. King, *op. cit*., p. 124.
10. Mel Zobel, pers. comm., March, 1975.
11. Cal. Food and Agric. Code 40844-40845.
12. See contractual standards, Table 1.
13. Anonymous grower, pers. comm.
14. Anonymous grower, pers. comm.
15. Charles G. Summers, *The Economic Impact of Integrated Pest Management in California Processing Tomatoes*. A report prepared for the Environmental Protection Agency, 18 pp.

16. John Nickelsen, Louis Rudd, and Everett Dietrick, pers. comm.

17. Mel Zobel, *op. cit.*

18. State of California Department of Food and Agriculture, *Pesticide Use Report by Commodity*, 1973, pp. 262-266.

19. W. R. Bowen, *et. al.*, "Pest and Disease Control Program for Tomatoes", Division of Agricultural Sciences, University of California, 1973.

20. Anonymous, *Cling Peach Almanac*, 1975, California Canning Peach Association, San Francisco, California, 1975.

21. John A. Jamison, "Marketing Orders and Public Policy for the Fruit and Vegetable Industries", *Food Research Institute Studies in Agricultural Economics, Trade, and Development*, Volume X, No. 3, 1971, p. 242.

22. *Ibid.*, p. 322.

23. *Ibid.*, p. 241.

24. *Ibid.*, pp. 371-377.

25. See Table 1.

26. See p. 126, below.

27. Jamison, *op. cit.*, p. 371.

28. *Ibid.*, p. 352.

29. *Ibid.*, p. 329.

30. *Ibid.*, pp. 326, 351, 352.

31. *Ibid.*, pp. 341-348.

32. Anonymous, *Cling Peach Quarterly*, Spring, 1974, pp. 7, 10.

33. Anonymous, *Cling Peach Almanac*, 1972, 1975.

34. Anonymous, *Pacific Fruit News*, June 5, 1976.

35. Anonymous, *Western Packing News*, June 15, 1976.

36. Anonymous, *Pacific Fruit News*, June 5, 1976.

37. S. C. Hoyt and L. E. Caltagirone, "The Developing Programs for Integrated Control of Pests of Apples in Washington and Peaches in California", in C. B. Huffaker, ed., Biological Control, Plenum Publishing Corporation, New York, 1971, pp. 412, 413.

38. Ronald Howthorne, "Estimated Damage and Crop Loss Caused by Insect/Mite Pests", 1972, 1974, California Department of Food and Agriculture, Sacramento, California.

39. California Department of Food and Agriculture, California Pesticide Use Report, 1974, Sacramento, California.

40. Anonymous, Cling Peach Almanac, 1975.

41. Caltagirone, op. cit., p. 419.

42. Ibid., p. 415.

43. Anonymous pest management consultant. This pest management consultant chose to remain anonymous because he feels that identification would result in pressure on growers, from processors and other sources, to discontinue his services.

APPENDICES

Table 1.

QUALITY STANDARDS FOR ORANGES, PEACHES, AND TOMATOES AS SPECIFIED BY VARIOUS PUBLIC AND PRIVATE AGENCIES

A. Oranges

1. State of California Quality Standards for Fresh Oranges.[1]

Article 5. Oranges Generally

(Article 5 heading amended by Stats. 1968, Ch. 738)

46951. As used in this article, "damage on the segment walls" means a water-soaked appearance, evidence of previous water-soaking, or the presence of crystals or crystalline deposit, on the two surface membranes of each of two or more segments as shown on the separation of two or more segments of a section. The section shall not be less than one inch or more than one and one-half inches in thickness, and shall be obtained from the central portion of the fruit by cutting off a portion of each end. Such evidence of freezing injury shall show for the entire length but not necessarily the entire area of the surface membranes.

46952. Oranges shall meet the requirements which are prescribed by this article.
(Amended by Stats. 1968, Ch. 738).

46953. Oranges shall be mature. Oranges, except bloods, tangerines, and mandarins, shall not be considered mature unless they comply with one of the following requirements:

(a) The juice contains soluble solids which are equal to or in excess of eight parts to every part of acid which is contained in the juice (the acidity of the juice to be calculated as citric acid without water of crystallization), and 90 percent or more of the oranges in any lot, by count, before picking have attained, on at least one-fourth of the fruit surface, at least a minimum characteristic orange color, as indicated by Color No. 7.5 Y 6/6, "Munsell Color."

(b) The juice contains soluble solids which are equal to or in excess of 10 parts to every part of acid which is contained in the juice (the acidity of the juice to be calculated as citric acid without water of crystallization), and 90 percent or more of the oranges in any lot by count before picking have attained, on at least one-fourth of the fruit surface, a minimum characteristic orange color, as indicated by Color No. 2.5 GY 5.6, "Munsell Color."

No oranges may be accelerated in color unless the juice contains soluble solids equal to, or in excess of, eight parts to every part of acid which is contained in the juice (the acidity of the juice to be calculated as citric acid without water of crystallization).

The tolerances which are allowed by Section 46961 do not apply to the provisions of this section when determining whether any lot of oranges complies with the maturity standard.
(Amended by Stats. 1968, Ch. 738)

46954. Oranges shall be free from decay.
(Amended by Stats. 1968, Ch. 738).

46955. Oranges shall be free from serious damage due to freezing. Damage from freezing to any one fruit is serious if it causes any of the following conditions:
(a) Damage on the segment walls, as defined in Section 46951.
(b) Drying or desiccation in 20 percent or more of the exposed pulp as shown on a transverse cut through the center.
(Amended by Stats. 1968, Ch. 738).

46956. Oranges shall be free from serious damage which is due to drying at the stem or stylar end which results from causes other than freezing. Damage by drying at the stem or stylar end of all oranges which results from causes other than freezing, is not serious unless 20 percent or more of the pulp shows staining, drying, or desiccation.
(Amended by Stats. 1968, Ch. 738).

46957. Oranges shall be free from damage which is caused by splits, bruises, or punctures. Damage which is caused by splits, bruises, or punctures in oranges is not serious if the injury is well healed and free from mold or decay.
(Amended by Stats. 1968, Ch. 738).

46958. In any season in which freezing damage to oranges which are produced in this state has occurred, the extent of damage by freezing to such oranges shall be determined as follows:
(a) By examination for damage on the segment walls from and after the time when the oranges were first exposed to freezing temperatures to the date, herein designated as date A, when the director, after survey, shall make a determination in writing that the drying process has developed to such extent as to furnish additional evidence of the extent of actual damage to the fruit.
(b) By examination of the exposed pulp on a transverse cut through the center, from and after the date, herein designated as date B, when the director, after survey, shall make a determination in writing that the drying process has developed to such extent as to permit reasonably accurate determination of the full extent of freezing damage by such examination, without regard to damage on the segment walls.
(c) Either by examination for damage on the segment walls or by examination of the exposed pulp on a transverse cut through the center, or by both such examinations, during the period from date A to date B. In no event shall the interval from date A to date B exceed three weeks.

Table 1 (continued)

46959. The extent of damage by freezing of oranges which were produced outside of this state that are offered for distribution and sale in this state shall be determined by the same methods and procedures as required for oranges produced in this state unless it is not practicable to obtain sufficient accurate information upon which to establish dates A and B as required by this article for such oranges. In such case the extent of damage by freezing in any lot of such oranges shall be determined as follows:

(a) By examination of the exposed pulp on a transverse cut through the center if examination of a representative sample of the oranges in the lot shows that the drying process has developed to such an extent as to permit reasonably accurate determination of the full extent of freezing damage.

(b) In any other case, by damage on the segment walls.

46960. The percentage of serious damage to oranges in containers, or in bulk, may be established by inspection of a representative sample which shall consist of not less than 100 fruits.

(Amended by Stats. 1968, Ch. 738).

46961. The following tolerances which are to be applied to the standards that are prescribed by this article are established by this section:

(a) With the exception of serious damage which is caused by freezing, not more than 10 percent, by count, of the oranges in any one container or bulk lot may be below the requirements, but with the exception of serious damage by drying at the stem or stylar end of oranges which results from causes other than freezing. Not to exceed one-half of this tolerance shall be allowed for any one cause.

(b) In the case of serious damage by freezing injury, not more than 15 percent, by count, of the oranges in any one container or bulk lot may be below the requirements, but not to exceed one-third of this tolerance shall be allowed for oranges which show a drying or desiccation in 40 percent or more of the exposed pulp, as shown on a transverse cut through the center.

(c) The total tolerance for a combination of defects shall not exceed the tolerance permitted for any one cause by more than 5 percent, by count.

(Amended by Stats. 1968, Ch. 738).

2. Sunkist Quality Standards for Fresh Oranges.[2]

(1) Compliance with Federal and State Laws.

No fruit will be marketed by Sunkist Growers, Inc. under any brand or grade, or at all, unless the same shall in all respects conform to the laws of the State of California or the State of Arizona, and, if the sale is made in Interstate Commerce, to Federal laws and to the laws of the place where the fruit is sold. The Field Department shall insepct all grades of citrus fruits marketed through Sunkist

Table 1 (continued)

Growers, Inc. and shall in every way endeavor to make uniform the enforcement of the regulations and laws concerning the marketing of California or Arizona citrus fruits.

Oranges

(2) Specifications for "Sunkist."

Oranges packed for marketing under the trademark Sunkist shall be mature; of one variety; of good eating quality and flavor; of good juice content; well grown specimens of normal form, picked from the tree; of good color for the variety; of good texture; practically free from scale or other insect pests, fungus diseases, splits, or defects of any kind that cause fruit to decay. The following classes of fruit shall be excluded: rough; coarse; more than slightly puffed; more than slightly scarred; more than slightly sunburned; misshapen fruit; dirty fruit unattractive to the consumer; fruit showing effects of frost or which cuts dry for any reason; immature fruit; fruit insipid in flavor; fruit deficient in juice content; and fruit green or very pale in color. Soft fruit or fruit showing marked evidence of aging or shriveling shall be excluded. Fruit of extra good texture and color may properly carry more scars than fruit possessing only the minimum of color and texture required under these "Sunkist" specifications. Oranges packed for marketing under the trademark Sunkist shall not vary more than 5 percent below foregoing specifications except that decay within this tolerance shall not exceed 1 percent.

(3) Specifications for "Excel."

Oranges packed for marketing under brands listed in the Sunkist Growers, Inc. brand list and/or manifested as "Excel" shall meet specifications for "Sunkist," except that as to interior defects, the minimum requirements of the State Agricultural Code shall apply. In the case of damage from frost, the determination shall be made by examination of the segment walls until that time when the interior drying process has developed sufficiently so as to furnish sufficient evidence of the degree of damage by this means. The tolerance for frost damage as evidenced in damage to the segment walls shall be 15 percent of the fruits, by count. When frost damage can be determined by drying, the amount of damage will be determined volumetrically by three equidistant cuts of the fruit. The tolerance for frost damage as evidenced by drying shall be 15 percent, by count, of the fruits showing a drying or dessication in 20 percent or more of the volume of the individual fruits, except that only 5 percent of fruits, by count, may show a drying or dessication in 40 percent or more of the volume of the individual fruits.

(4) Specifications for "Red Ball."

Oranges packed for marketing under the trademark Red Ball shall be mature; of one variety; of good eating quality and flavor; of good

Table 1 (continued)

juice content; well grown specimens of fair form, picked from the tree; of fair color for the variety; of fair texture; practically free from insect pests (other than scale), fungus diseases, splits, or defects of any kind that cause fruit to decay. The following classes of fruit shall be excluded: very rough; very coarse; badly sunburned; badly scarred; badly puffed; very scaly or very dirty fruit; fruit showing effects of frost or which cuts dry for any reason; immature fruit; fruit insipid in flavor; fruit deficient in juice content; and fruit very green in color. Soft fruit or fruit showing marked evidence of aging or shriveling shall be excluded. Fruit of extra good texture and color may properly carry more scars than fruit possessing only the minimum of texture and color required under these "Red Ball" specifications. Oranges packed for marketing under the trademark Red Ball shall not vary more than 5 percent below foregoing specifications with the following exceptions: Decay within this tolerance shall not exceed 1 percent; as to fruit showing effects of frost or which cuts dry for any reason, the total tolerance shall be 10 percent, but not more than half of this tolerance shall be allowed for serious drying or freezing damage as defined in the State Agricultural Code.

(5) Maturity of Valencia Oranges.

In addition to the 8 to 1 maturity test, valencia oranges to be eligible for marketing under the trademarks Sunkist and Red Ball must have a Brix reading of not less than 9.0.

(6) Storage Limitations for Oranges.

Oranges, subject to all other regulations as to inspection, etc., will not be marketed under the trademarks Sunkist or Excel, except as herein provided, if they have been off the trees more than 28 days, except that, after the following dates - January 1 on Central-Northern California and Arizona navels; March 1 on Southern California navels and miscellaneous, and Arizona valencias and miscellaneous; June 15 on Central-Northern California valencias; and August 1 on Southern California valencias - the storage limitation shall be 21 days. Associations, at the conclusion of the above dates, may only ship after those dates by certification by the Field Department at time of shipping, such certification to consist of grade, pack, condition, injury and flavor certification, i.e., inspection with "B" grade and pack, "2" condition and injury, and satisfactory flavor classifications as minimum requirements for certification.

Each shipper must furnish the Field Department accurate and positive information of the date fruit has been picked; and further, all containers must be marked with a code or date indicating the date packed. Failure to comply with these requirements will disqualify all fruit concerned for marketing under the Sunkist or Excel trademarks for association account. Should association ship fruit beyond

Table 1 (continued)

the storage limitation without Field Department certification, association will be assessed $1.00 per carton as liquidated damages, in addition to any other penalties provided for or allowed in these rules and regulations or in the bylaws of Sunkist Growers, Inc.

The Sales Division and Field Department shall have authority to make equitable adjustments on fruit picked during the first 30 days of any varietal season in any area when during that period domestic prorate allotments have not been sufficient to permit shipment of sizes not wanted in export markets.

B. Peaches

1. State of California Quality Standards for Fresh Peaches[1]

48731. Fresh peaches shall be mature, but not overripe, and free from any of the following defects:

(a) Insect injury which has penetrated or damaged the flesh.

(b) Split pits which are open at the stem end.

(c) Mold, brown rot, and decay.

(d) Serious damage, due to cuts or skin breaks, growth cracks, bruises, scab, rust, blight, disease, hail, or other causes.

Damage to any one peach is not serious unless it causes a waste of 10 percent, by weight, of the individual peach.

48732. Peaches of the freestone variety shall not be considered mature unless, at the time of picking, the flesh breaks free from the pit. In addition, the flesh of peaches of the Elberta variety shall be a yellowish color.

48733. Not more than 10 percent, by count, of the peaches in any one container or bulk lot may be below the requirements which are prescribed by this article, but not to exceed one-half of this tolerance shall be allowed for any one cause. Individual containers in any lot may, however, contain not more than 1 1/2 times the tolerances specified if the percentage of defects of the entire lot averages within the tolerances.

2. Federal Food and Drug Administration Defect Action Levels For Processing Peaches.[3]

Average of 5% wormy or moldy fruit by count or 4% if a whole larva or equivalent is found in 20% of the cans.

3. Processor Marketing Order Quality Standards for Processing Peaches.[4]

1. "Cling Peaches" means peaches, the pits or stones of which closely adhere to the flesh when the fruit is ripe.

Table 1 (continued)

2. a. "Number 1 Cling Peach" means any cling peach suitable for canning or freezing, not less than two and three-eighths inches (2-3/8" or 60.32 millimeters) in diameter, ring measure, and of good shape, color, texture, and quality, in good condition for canning or freezing, and of a maturity and flesh color suitable to yield a canned or frozen product of choice grade, as such grade is generally known in the canning or freezing industries; provided, that if the Director, pursuant to the provisions of Subsection 3, Section D, Article IV, of this Marketing Order, establishes minimum flesh color requirements as a measure of peach maturity, each Number 1 Cling Peach shall meet those requirements. The minimum diameter requirements established herein shall in no event be construed as limiting or restricting the delivery of Number 1 Cling Peaches of a diameter larger than such minimum diameter requirements.

(1) Any cling peach shall not be classed as a Number 1 Cling Peach if it has worms or worm damage, a gum pocket, rot, brown rot, black flesh, green core, if it is overripe, if it is a windfall, if it is a visible split-pit, or if it has more than a reasonable amount of mildew, scab, red streaks in the flesh, bruises, cuts, tears or punctures, parasite or insect damage, hail damage, San Jose scale, sunburn, shothole fungus, or other imperfections. Cling peaches having invisible split-pits shall be classified as specified hereafter in this Section.

(2) A cling peach shall be considered to have more than a reasonable amount of the above defects if:

(a) It has mildew infection of more than two spots with one of the spots being larger than one-fourth inch (1/4") in diameter, or one spot larger in diameter than a penny, or any spot containing a crack or fissure more than skin deep, or any spot that is warted.

(b) It has scab resulting from limb rub or other causes longer or wider than the diameter of a penny or if the scab is cracked.

(c) It has red streaks in the flesh to such extent that the peach is not suitable to yield a canned or frozen product of choice grade, as such grade is generally known in the canning or freezing industries.

(d) It has bruises that result in discoloration of the peach so that it will not yield a product of choice grade. Bruises which accidentally occur at the inspection station shall be exempt and shall not be considered as defects.

(e) It has cuts, tears or punctures, except those that accidentally occur at the inspection station, sufficiently severe that the peach is not suitable to yield a canned or frozen product of choice grade, as such grade is generally known in the canning or freezing industries.

(f) It has parasite or insect damage or hail damage that has penetrated the skin.

(g) It has San Jose scale that has matured and hardened.

(h) It has sunburn, shothole fungus, or other imperfections that do not peel in the normal lye peeling process, or that result in the peach not being suitable to yield a canned or frozen product of choice grade, as such grade is generally known in the canning or freezing industries.

(3) A cling peach shall be considered overripe if it shows deterioration as a result of overmaturity as indicated by wilting, softness, browning, or tissue breakdown.

(4) A cling peach shall be considered to be a visible split-pit if it has an opening at the stem end. A cling peach shall be considered as having an invisible split-pit when the peach, including the pit, can be pulled apart by the use of hands. Fifty percent (50%) of the cling peaches having invisible split-pits in any lot shall not be classed as Number 1 Cling Peaches.

(5) Bruises, cuts, tears or punctures resulting from mechanical sorting devices, even though such mechanical sorting devices may be operated in conjunction with an inspection station, shall not be considered accidental and do not qualify for exception.

The entire shipment of cling peaches will be rejected for processing if the net weight of off-grade cling peaches due to brown rot exceeds five percent of the total net weight of the shipment or the net weight of off-grade cling peaches due to worms or worm damage, either or both, exceeds four percent of the total net weight of the shipment.

4. Processor-Grower Contractual Quality Standards.[5]

In addition to the marketing order quality standards, a California Canners League Contract for peaches reads:

> Seller shall deliver at point of delivery promptly after harvesting all peaches covered hereby of good shape, quality, and suitable for canning as herein defined, at the state of maturity Buyer may require, free from worms, worm damage, gum pockets, rot, brown rot, black flesh, green core, overripe peaches, windfalls, split pits, mildew, scab, sunburn, red streaks in the flesh, bruises, parasite or insect damage, hail damage, San Jose scale, shothole fungus, or other imperfections. All peaches shall also be of a color and texture suitable for canning into Choice grade as such grade is generally understood in the canning trade.
>
> Buyer may . . . reject any delivery or partial delivery containing in excess of 10% culls or in excess of 2% Rot and or Brown Rot, or

Table 1 (continued)

in excess of 1% wormy or worm damaged peaches. Culls shall consist of any peaches not conforming to grade, size and quality specifications set forth in paragraph 6 hereof. (Paragraph directly above.)

C. Spinach

1. State of California Quality Standards for Fresh Spinach.[1]

No specific quality standards for spinach.

2. Federal Food and Drug Administration Defect Action Level for Spinach For Processing.[3]

Average of 50 aphids, thrips and/or mites per 100 grams.

Two spinach worms (caterpillars) or fragments of 3 mm. in length having an aggregate length of 12 mm. per 24 pounds of spinach.

Average of 8 leaf miners of any size per 100 grams; or an average of 4 leaf miners 3 mm. in length per 100 grams.

Average of 10% leaves by count or weight show mildew or other type of decomposition 1/2 in. in diameter.

3. Processor-Grower Contractual Quality Standards for Spinach.[6]

A Stokely-Van Camp, Inc. contract for spinach reads:

Seller shall deliver, at point of delivery, promptly after harvesting, all vegetables suitable for freezing as herein defined covered by this contract, in the condition Buyer may require, in order to meet the tolerances permitted by and requirements of the United States Food and Drug Administration, and in all respects conforming to any applicable Pure Food and Drug requirements of the state or political subdivision thereof in which this contract is to be performed and the crop is to be processed.

Buyer may reject any vegetables delivered or tendered for delivery hereunder not complying with this contract and may charge the same and all costs, freight and expenses incurred in connection with the receipt and return thereof back to Seller, giving notice in writing of any such rejection to Seller, or his agent, provided, however, that the rejection of any delivery or partial delivery or any grading down or regrading of any delivery or partial delivery at point of delivery specified herein by Buyer, shall not relieve the Seller from his obligation to deliver the balance of the vegetables purchased hereunder, and to this extent this contract is severable.

Irrespective of any provisions of this contract relating to the point of delivery or passage of title, Buyer shall have the right

Table 1 (continued)

to grade the vegetables delivered hereunder at its plant and the right to rejection is reserved to the Buyer until after such grading.

Spinach for freezing shall consist of fresh spinach of good typical green color, free from decay, dirt, minor damage, worms and insects, major damage to leaves or stems, weeds, roots and root stubs, pink stems, excessive stems and stem length, seed stalks, crown, free moisture, and free from damage caused by frost, hail, insects, smog, mechanical or other means.

Any lot of spinach infested with insects including worms or aphids or seriously damaged by any of the above listed defects beyond the level normally accepted in the frozen spinach industry, may be rejected by Buyer.

D. Tomatoes

1. California State Quality Standards for Fresh Tomatoes.[1]

50601. Tomatoes shall be mature, but not overripe, and shall be free from any of the following defects:

(a) Pinworm damage which has penetrated beyond the tissue making up the base of the core of the tomato, other insect injury which has penetrated or damaged the flesh, and mold, decay, and wet or soft rots.

(b) Serious damage due to freezing, blossom end rot, mosaic, alkali spot, sunscald, bruises, catfaces, growth cracks, or other causes. Damage to any one tomato is not serious unless it causes a waste of 10 percent, by weight, of the individual tomato.

50602. Not more than 10 percent, by weight, of the tomatoes in any one container or bulk lot may be below the requirements which are prescribed by this article, but not to exceed one-half of this tolerance shall be allowed for any one cause.

2. State of California Quality Standards for Processing Tomatoes.[7]

A tomato shall not be regarded as suitable for canning purposes if, as established by inspection of a representative sample, it has any of the following defects:

(a) Any worm or worm damage is present which has penetrated the flesh of the tomato.

(b) In excess of 10 percent of the weight of the tomato cannot be used for canning purposes due to the presence of mold.

(c) In excess of 20 percent of the weight of the tomato cannot be used for canning purposes due to the presence of rot.

(d) In excess of 25 percent of the weight of the tomato cannot be used for canning purposes due to the presence of sunburn, sunscald, growth cracks, insect bites, pest infections, hail damage, or other specifications which are not specified in this article.

Table 1 (continued)

(e) The tomato is sufficiently overripe to make it useless for canning purposes.

(f) The tomato is shriveled, frozen, or frosted.

(g) The external surface of the tomato is green, with no visible shade of red color.

Any load of tomatoes which is offered for delivery to a canner shall be rejected and turned back to the grower if in excess of 2 percent of the delivery, by weight, does not comply with subdivision (a) of (the above paragraph) or if in excess of 8 percent of the delivery, by weight, does not comply with subdivision (b) of (the above paragraph).

Any load of tomatoes which is offered for delivery to a canner shall be rejected and turned back to the grower if in excess of 15 percent of the delivery, by weight, does not comply with subdivisions (a) to (g), inclusive (of the paragraph above.)

Any load of tomatoes which is offered for delivery to a canner shall be rejected and turned back to the grower if more than 2 percent of the delivery by weight is green as defined (above).

Any load of tomatoes which is offered for delivery to a canner shall be rejected and turned back to the grower if the load does not meet the minimum requirements for color based on comminuted raw product sampling.

3. Federal Food and Drug Administration Defect Action Levels For Processing Tomatoes.[3]

Tomato Catsup	Microscopic mold count average of 30%
Tomato Juice	Microscopic mold count average of 20%.
Tomato Paste or Puree	Microscopic mold count average of 40%.
Tomato Sauce (undiluted)	Microscopic mold count average of 40%.
Canned Tomatoes, with or without added tomato juice	Microscopic mold count average of the drained juice is 12%.
Canned Tomatoes packed in Tomato Puree	Microscopic mold count average of the drained packing media is 25%.
Pizza Sauce (based on 6% total Tomato solids after pulping)	Microscopic mold count average of 30%.
Tomato Soup and other Tomato products	Microscopic mold count average of 40%.
Tomatoes (canned)	10 Drosophila fly eggs per 500 grams; or 5 Drosophila fly eggs and 1 larva per 500 grams; or 2 larvae per 500 grams.

Table 1 (continued)

Tomato Juice	10 Drosophila fly eggs per 100 grams; or 5 Drosophila fly eggs and 1 larva per 100 grams; or 2 larvae per 100 grams.
Tomato Puree	20 Drosophila fly eggs per 100 grams; or 10 Drosophila fly eggs and 1 larva per 100 grams; or 2 larvae per 100 grams.
Tomato Paste, Pizza and other Sauces	30 Drosophila fly eggs per 100 grams; or 15 Drosophila fly eggs and 1 larva per 100 grams; or 2 larvae per 100 grams.

4. Processor-Grower Contractual Quality Standards[8]

A Canners League of California Tomato Contract reads:

No tomato shall be deemed suitable for canning if:

(a) Any worm or worm damage is present which has penetrated the flesh of the tomato.

(b) In excess of ten percent of the weight of the tomato cannot be used for canning purposes due to presence of mold.

(c) In excess of twenty percent of the weight of the tomato cannot be used for canning purposes, due to the presence of rot.

(d) In excess of twenty-five percent of the weight of the tomato cannot be used for canning purposes due to the presence of sunburn, sunscale, growing cracks, insect bites, pest infections, hail damage, green or yellow color at the stem end, or other imperfections not specified in (this paragraph) of the contract.

(e) The tomato is sufficiently overripe to make it useless for canning purposes.

(f) The tomato is shriveled, frozen or frosted.

(g) It is not well colored by which is meant that the color fails to meet minimum standard . . . as defined in Title III, Section 1331 of the California Administrative Code;

(h) It is green with no visible shade of red color on the external surface.

Any load of tomatoes offered for delivery hereunder may be rejected at Buyer's option and turned back to seller if:

(a) Over one-half (1/2) of one (1) percent of the tomatoes in the delivery by weight fails to comply with subsection (a) of (the) paragraph above.

(b) Over one (1) percent of the load by weight fails to comply with subsection (b) in (the) paragraph above.

(c) Over two (2) percent of the load by weight fails to comply with subsection (h) of (the) paragraph above.

(d) Over fifteen (15) percent of the delivery by weight fails to comply with subsections (a) to (h) of (the) paragraph above.

(e) Over ten (10) percent of the tomatoes in the delivery by weight are cracked or broken.

(f) Such load contains mud-smeared tomatoes, loose dirt, or other foreign matter.

Table 1 (continued)

Other processor contracts for tomatoes contain similar provisions. (See Appendix A, below).

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[1] California state standards for fresh produce are specified in California State Food and Agriculture Code 42501-50833.

[2] "Rules and Regulations Governing Fruit Packed For Marketing by Sunkist Growers, Inc. under its Trademarks Sunkist, Excel, SK, and Red Ball and Under Association Non-Advertised Brands," Sunkist Growers, Inc., Nov. 1, 1967.

[3] "Current Levels for Natural or Unavoidable Defects In Food For Human Use that Presents No Health Hazard" HFF-342 HEW-PHS-FDA, Washington, D. C., 1976.

[4] Processors Marketing Order for Cling Peaches as Amended 1973-1975, California Department of Food and Agriculture, Sacramento, California.

[5] California Canners League Contract for Peaches, See Appendix A.

[6] Stokely-Van Camp, Inc. Contract for Spinach, See Appendix A.

[7] California State Food and Agriculture Code, 40844-40845.

[8] California Canners League Contract for Tomato, See Appendix A.

TABLE 2

POUNDS OF PESTICIDES USED IN CALIFORNIA IN 1974[1]

Pesticide	Used On Specialty Crops*	For all Uses	Percent Used On Specialty Crops
Aldrin	12417	30750	40
Carbaryl	665456	1007768	66
Chlordane	135145	601000	22
DBCP	674032	728643	92
D-D Mixture	1940318	2918144	66
Diazinon	200744	353584	57
Dieldrin	11701	59883	20
Dimethoate	316826	471417	67
Ethion	123018	133431	92
Guthion-R	276751	334439	83
Kelthane	51278	525441	10
Lindane	633	12342	5
Malathion	271089	554729	49
Meta-Systox	353539	84388	63
Methomyl	3 67409	781556	47
Methyl-Parathion	257740	485085	53
Naled	162136	404290	40
Omite-R	216631	790294	27
Parathion	664253	1017115	65
Phosdrin-R	143500	182765	79
Phosphamidon	312522	329015	95

* Almonds, Apple, Apricot, Artichoke, Avocado, Beets, Broccoli, Brussel Sprouts, Cabbage, Carrot, Cauliflower, Celery, Cherries, Citrus, Cucumber, Eggplant, Figs, Grapes, Grapefruit, Lettuce, Melons, Nectarines, Olives, Peach, Pear, Peppers, Plum, Potato, Prune, Pumpkins, Squash, Strawberries, Tomato, Turnip and Walnut.

[1] *California Pesticide Use Report, 1974*, California Department of Food and Agriculture, Sacramento, 1975.

Table 3

The arthropod pests of California agricultural crops, each of which in 1970 caused losses of a million or more dollars, and a summary of their insecticide resistance, their status as resurgent or secondary outbreak pests, and the secondary pest outbreaks associated with their chemical control. (From Luck _et al_., 1977 _BioScience_ (in press)).[1]

Pest species	Types of insecticides to which species exhibit general or specific resistance[2]										Species resistant in California	Associated resurgence or secondary pest outbreaks
	Botanicals	DDT + Relatives	Cyclodienes	Organo Phosphates	Carbamates	Sulfomates, etc.	Lime Sulfer	Heavy Metals	HCN Gas	Tartar emetic		
Citrus red mite _Panonychus citri_ (McGregor)		X		X		X					X	X
European red mite _Panonychus ulmi_ (Koch)		0		X		X					X	X
Pacific spider mite _Tetranychus pacificus_ McGregor		0		X							X	X
Two-spotted spider mite _Tetranychus urticae_ (Koch)		X		X		0					X	X
Citrus thrips _Scirtothrips citri_ (Moulton)		0	0	0						X	X	X

Table 3 (cont.)

Artichoke plum moth Platyptilia carduidactyla (Riley)			O			O	X
Potato tuberworm Phthorimaea operculella (Zeller)	X	X	X				X
Pink bollworm Pectinophora gossypiella (Saunders)	X		O			O	X
Peach twig borer Anarsia lineatella Zeller	[illegible] O				X	X	X
Omnivorus leafroller Platynota stultana Walsingham							X
Codling moth Laspeyresia pomonella (Linneaus)	X		O,O		X	X	X
Oriental fruit moth Grapholitha molesta (Busck)	X						X
Cotton leaf perforator Bucculatrix thurberiella (Busck.)		X	X	X		O,O	X
Alfalfa weevils Hypera spp.	O	O				O	X

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[1] All cases of insecticide resistance, target pest resurgence and secondary pest outbreaks cited here have either been reported in the literature or via personal communication by research specialists.

[2] T = Tolerant to insecticide

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Table 3 (Cont.)

Consperse stinkbug Euschistus conspersus Uhler							X
Lygus bug Lygus hesperus Knight	X		X			X	X
Pear psylla Psylla pyricola Foerster	T	X	O	X		O	X
Cabbage aphid Brevicoryne brassicae (Linnaeus)							
Citrus aphid Aphis citricola van der Goot							X
Green peach aphid Myzus persicae (Sulzer)	O	X	X			O	X
California red scale Aonidiella aurantii (Maskell)					X	X	X
San Jose scale Aspidiotus perniciosus Comstock				X			X
Tomato fruitworm-cotton bollworm-corn earworm Heliothis zea (Boddie)	X		X	X		X	X
Beet armyworm Sppdoptera exigua (Hubner)	O						X
Cabbage looper Trichoplusia ni (Hübner)	X	X	X			O	X

Table 4

Returns for Fresh and Processed Oranges, in California and Florida, 1940-41 to 1973-74

	Calif. Navel		Calif. Valencia		Florida oranges	
Year	Fresh $/box[1]	Processed $/box[1]	Fresh $/box[1]	Processed $/box[1]	Fresh $/box[1]	Processed $/box[1]
1940-41	.98	.20	1.55	.44		
1945-46	2.82	.12	3.52	1.76		
1950-51	2.43	.37	2.14	.41		
1955-56	2.96	.06	3.05	1.04		
1960-61	5.24	.48	3.71	1.82		
1965-66	1.39	.04	1.61	.61	.88	.80
1966-67	1.48	.04	1.31	.31	.30	.48
1967-68	2.95	.06	2.56	.51	1.30	.98
1968-69	1.49	-.11	1.10	.06	.99	.83
1969-70	1.41	-.12	1.55	.21	.73	.56
1970-71	1.77	-.17	1.55	.14	.91	.71
1971-72	1.50	-.18	1.28	.18	1.25	1.01
1972-73	2.14	-.30	1.83	.18	.93	.77
1973-74	1.92	-.43	1.76	.00	1.14	.76

Source: 1940-1960 - Walter Reuther, ed., The Citrus Industry, University of California, 1967, p. 70.
1965-1973 - USDA Crop Reporting Board - Citrus Fruits by States,
Agricultural Prices; Florida Agricultural Statistiscs

[1] For 1940-1960 a box = 75 lbs.

For 1965-1974 a box = 50 lbs.

Table 5

Production Levels and Prices of California Oranges from 1949-50 to 1973-74

	California Navels					California Valencias				
Year	Prod.	Fresh	Proc.	Price	Value	Prod.	Fresh	Proc.	Price	Value
49-50	14909*	13003*	1906*	2.25	33545#	25825*	14555*	11270*	1.89	48809#
50-51	14200	13147	1053	2.63	37346	30179	17928	12251	1.79	54020
51-52	12121	10338	1783	2.75	33333	25394	16895	8499	1.83	46471
52053	16385	14785	1600	1.99	32606	28970	19670	9300	1.68	48670
53-54	14080	11945	2135	2.49	35059	17585	13028	4557	3.01	52931
54-55	14887	12816	2071	2.52	37515	23730	15000	8730	2.31	54816
55-56	14693	13070	1623	3.04	44667	22880	14330	8550	2.70	61776
56-57	15000	13280	1720	2.96	44400	20200	12100	7100	2.27	45854
57-58	8860	8485	375	4.82	42705	13858	10978	2880	4.64	64301
58-59	16610	14530	2080	3.08	51159	22890	14460	8430	2.74	62719
59-60	30240	22530	7710	3.78	114290	17040	10980	6060	3.81	64922
60-61	24600	19130	5470	4.10	100890	15840	10880	4960	3.30	52272
61-62	7360	6660	700	6.03	44381	12890	8630	4240	3.65	46976
62-63	12270	90000	3270	4.39	53865	16200	9380	6820	3.67	59454
63-64	14950	12636	2314	3.84	57408	16300	9800	6500	4.43	72209
64-65	15200	13880	1320	3.70	56240	16100	11130	4970	2.56	41216
65-66	18200	14090	4110	2.90	52780	17500	10950	6550	3.25	56875
66-67	16900	14540	2360	3.24	54756	19600	12380	7220	2.27	44492
67-68	9100	5530	3570	4.33	39403	9950	6110	3840	4.44	44178
68-69	18525	14190	4335	3.12	57798	24900	12900	12000	2.03	50547
69-70	21144	15949	5195	2.74	7935	17700	10400	7300	2.73	48321
70-71	17865	14690	3175	3.65	65207	20650	11250	9400	2.92	60298
71-72	22300	16600	5700	3.11	69353	21100	10820	10280	2.55	53805
72-73	18700	12500	6200	3.52	65824	23400	11600	11800	2.83	66222
73-74	21900	17400	4500	4.03	88257	18800	12100	6700	3.65	68620

* in thousands of tons # in thousands of dollars

e: Citrus Fruits, Statistical Reporting Service USDA 1949-74

Table 7

CITRUS PEST HIERARCHY IN CENTRAL CALIFORNIA [1]

Under Conventional Control

1. Citrus thrips
2. Citrus red mite
3. Red scale*, Yellow scale
4. Various Lepidoptera, e.g. Cutworms, Leafrollers
5. Cottony-cushion scale
6. Citricola scale
7. Brown soft scale
8. Leafhoppers
9. Orange dog, aphids, katydids

Under Integrated Management

1. Citricola scale
2. Citrus thrips
3. Various Lepidoptera
4. Citrus red mite
5. Yellow scale
6. Cottony-cushion scale
7. Brown soft scale
8. Leafhoppers
9. Orange dog, aphids, whiteflies

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* The experience of the last few seasons indicates that red scale should be ranked number one or two under both conventional and integrated pest management.

[1] According to C. E. Kennett, citrus entomologist, University of California, Berkeley.

Table 6

Summary of Interviews with Nine Citrus Growers

1. Location of ranch: Central California..........6
California/Arizona Desert...3

2. Acreage: Range = 10--3500 acres, Average = 905 acres

3. Crops grown: Navel Orange.....5 (Most growers raise more than one citrus crop)
Valencia Orange..7
Grapefruit.......2
Lemon............3
Tangerine........2

4. What are the major pests: Thrips...........8
Red Scale........5
Mites............5
Worms............3
Citricola scale..2
Aphids...........1
Leaf Roller......1

5. Which pests are considered wholly or partially cosmetic?

Thrips..........8
Mites...........4
Red scale.......3 (partially in all cases)
Citricola scale.1
Soft brown scale1
Worms...........1

6. What proportion of pest control cost is necessary to meet cosmetic standards?

0-50%.....0
50-75%....4 Average = 71%
75-100%...5

7. Do U.C. pest control recommendations take integrated control into account?

Yes..2
No...6

8. Does your buyer adjust quality standards according to prevailing market conditions?

Yes..8
No...0

9. How is the crop marketed?

Cooperative...........4
Packinghouse Contract..3
Independent...........1

LE 8

CONVENTIONAL AND INTEGRATED PEST MANAGEMENT FOR CITRUS PESTS IN CENTRAL CALIFORNIA[1/]

Pest Species	Timing of Treatment		Pesticides		Natural Enemies	
	Conventional	Integrated	Conventional	Integrated	Conventional	Integrated
Citrus thrips	May-post petal fall	Post petal fall	guthion, Dimethoate Delnav Phosphamidon	Ryania* parathion(OC)$^{+}$	----	ineffective
Citrus red mite	Spring	Winter Summer Spring	Kelthane Omite Chlorobenzilate	NR oil	----	effective some years
Red scale	Spring	Summer	parathion malathion parathion + malathion NR oil	carbaryl + NR oil NR oil parathion(TC)$^{+}$	----	partially effective
Yellow scale	Spring	----	same as red scale	none	----	effective
Brown soft scale	Spring Summer Fall	----	malathion (most disruptive chemical for citrus)	none	----	effective
Citricola scale	Summer	Summer Fall Winter	parathion NR oil	carbaryl + NR oil parathion (OC) NR 415 oil	----	ineffective
Katydid	Spring	Spring	parathion	parathion (OC)	----	ineffective
Fruit tree leaf roller and cutworms	Spring	Spring	guthion parathion Dibrom	Bacillus thuringiensis parathion (OC) carbaryl		ineffective
Leafhoppers	Fall	Fall	hydrated lime	hydrated lime	----	ineffective
Citrus aphids	Spring	Spring	rotenone	rotenone rotenone + oil	----	effective

*Pesticides for I.C. listed in order of preference

TABLE 9

Pest Control Costs in California Citrus Conventional vs. Integrated Pest Management[1/]

Sample Cost per Acre (Tulare County)

ALTERNATIVE USE OF CHEMICALS

Traditional Pest and Disease Control

Major Pest Problem	Solution	Cost per Acre
Citrus thrips	Prebloom—organophosphate	
Red and yellow scale	Petal fall—organophosphate	29
Citrus red mite	Summer—organophosphate or botanicals for thrips	9
Citricola scale		
Leafroller		
Cutworms	Fall—miticide for mites	26
Orange dog		
Brown soft scale	Fall whitewash—fungicide	19
Leafhoppers		
Brown rot and Septoria spot		
TOTAL		$101

Intregrated Pest and Disease Control

Major Pest Problem	Solution	Cost per Acre*
Citrus thrips	Higher threshold of economic damage	
Citricola scale	*Single* prebloom organophosphate	$ 18
Leafroller	On thrips and mites—a number of predaceous insects plus diseases	
Cutworms		
Yellow and red scales	Parasite—*Comperella bifasciata*	none
Brown soft scale	Parasite—*Aphycus luteolus*	none
Citrus red mites		
Orange dog		
Leafhoppers	Optional, depending on monitored population	
Thrips (latter season)	Petal to postbloom—botanicals (two applications at $9.00)	$ 9
Brown rot and Septoria spot	Fall whitewash—fungicide	$ 18
TOTAL		$ 45

Pest and disease cost as percentage of total input costs	11.2%
Difference between traditional and integrated programs	$56 per acre
Savings as a reduction of net loss	80.3%

* Yield averages for 5-year period, 1965–1970, on 1,000 acres at Orange Cove in Tulare County:
Blocks planted since 1950 produced 700 to 1,000 field boxes per acre
Blocks 40 years and more old produced 300 to 500 field boxes per acre
Packout at 50% with year-long pack (higher with seasonal pack)
NOTE: Navel oranges—500 to 700 boxes with less than 100% packout (year long)

Reproduced from best available copy.

[1/] From R. Smith, "What is Being Done by the University," Agricultural Chemicals—Harmony or Discord, p. 141.

Figure 1

NAVEL ORANGES.

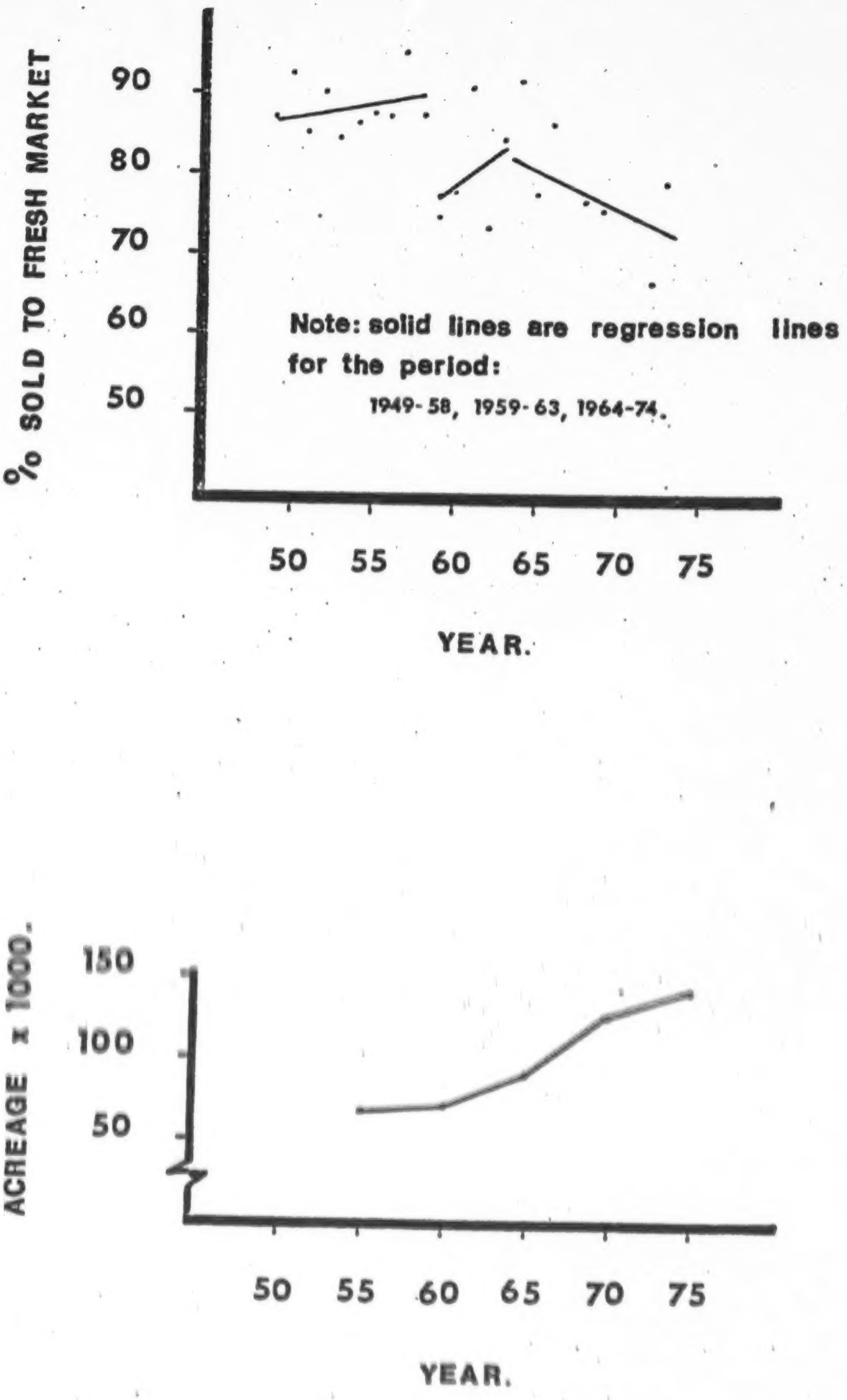


Figure 2

VALENCIA ORANGES.

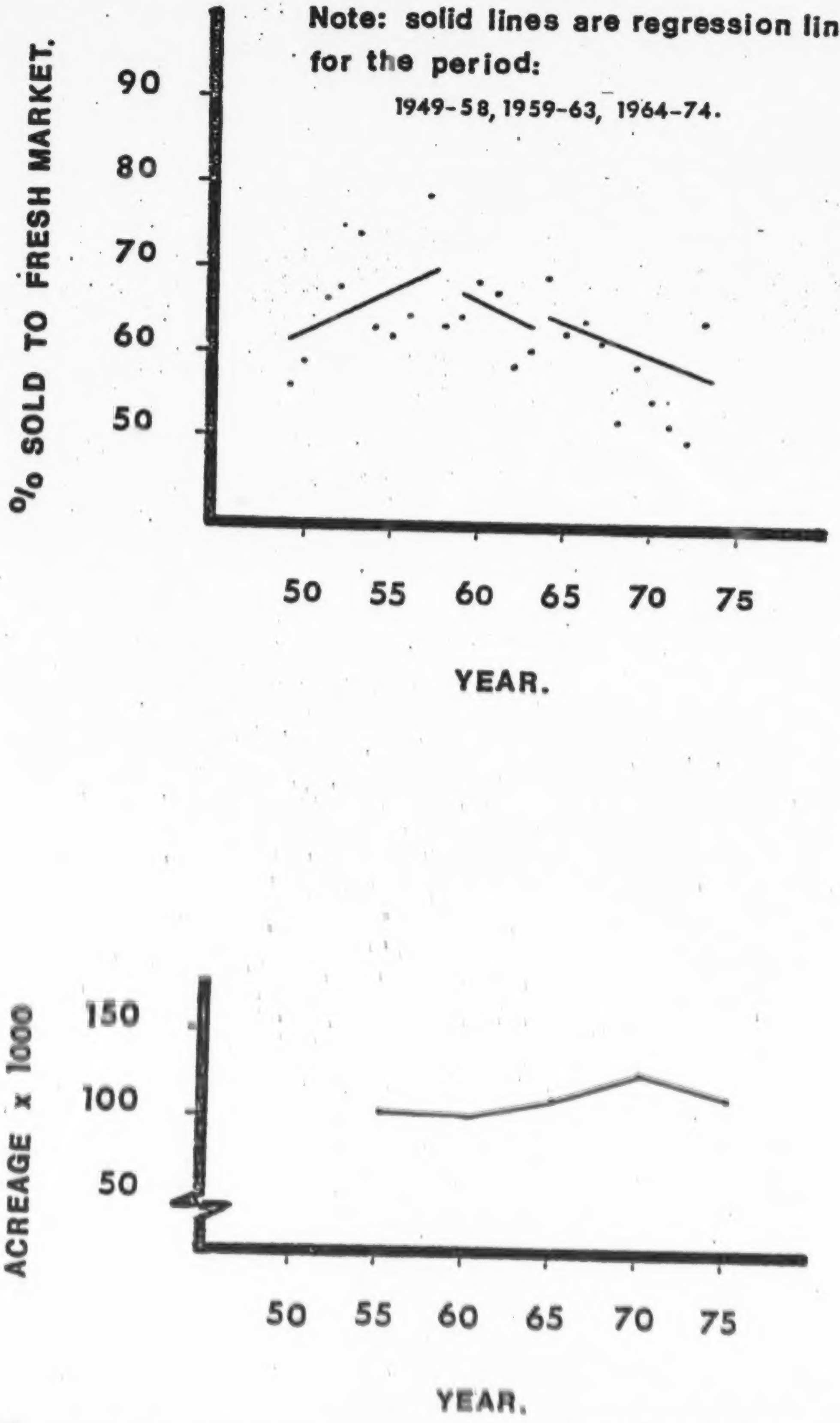
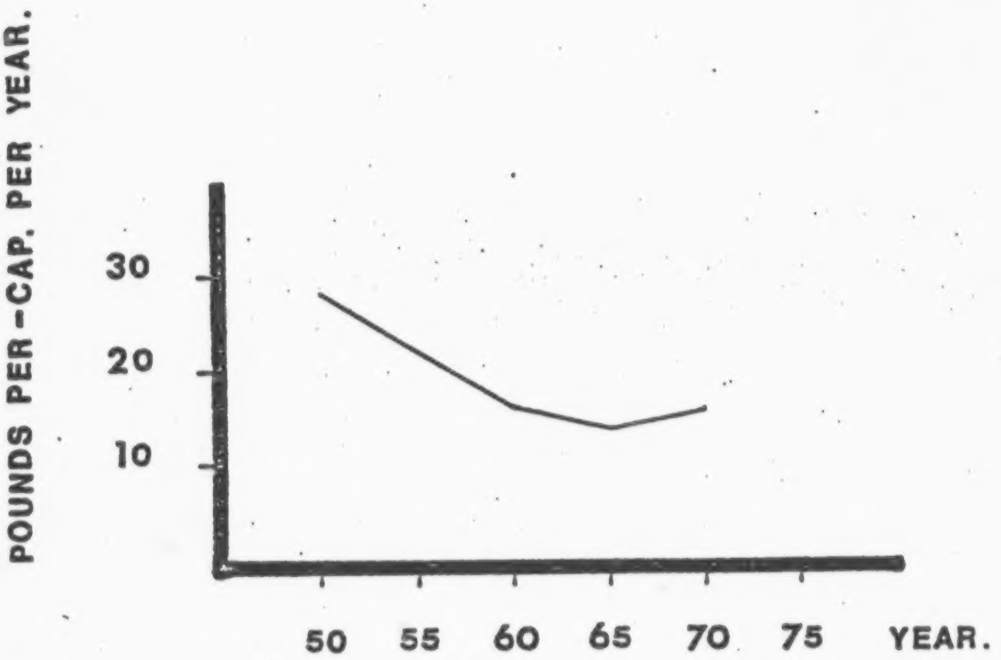
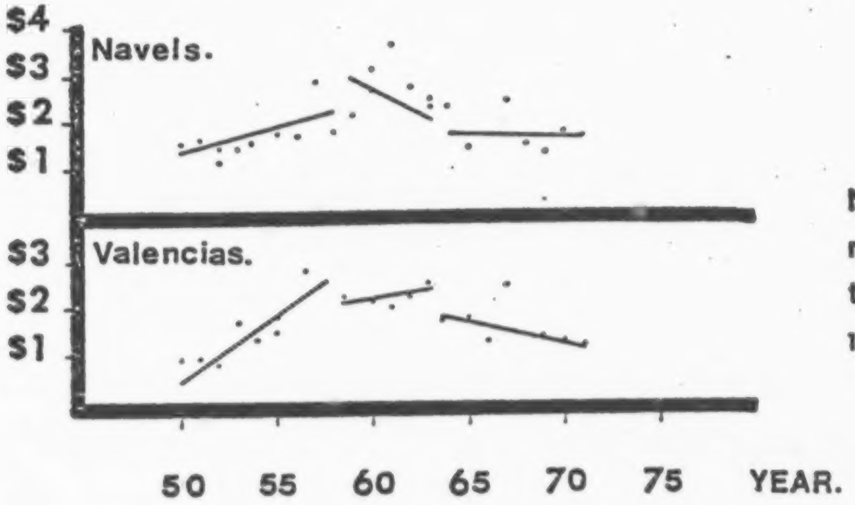


Figure 3 **PER-CAPITA CONSUMPTION OF FRESH ORANGES.**



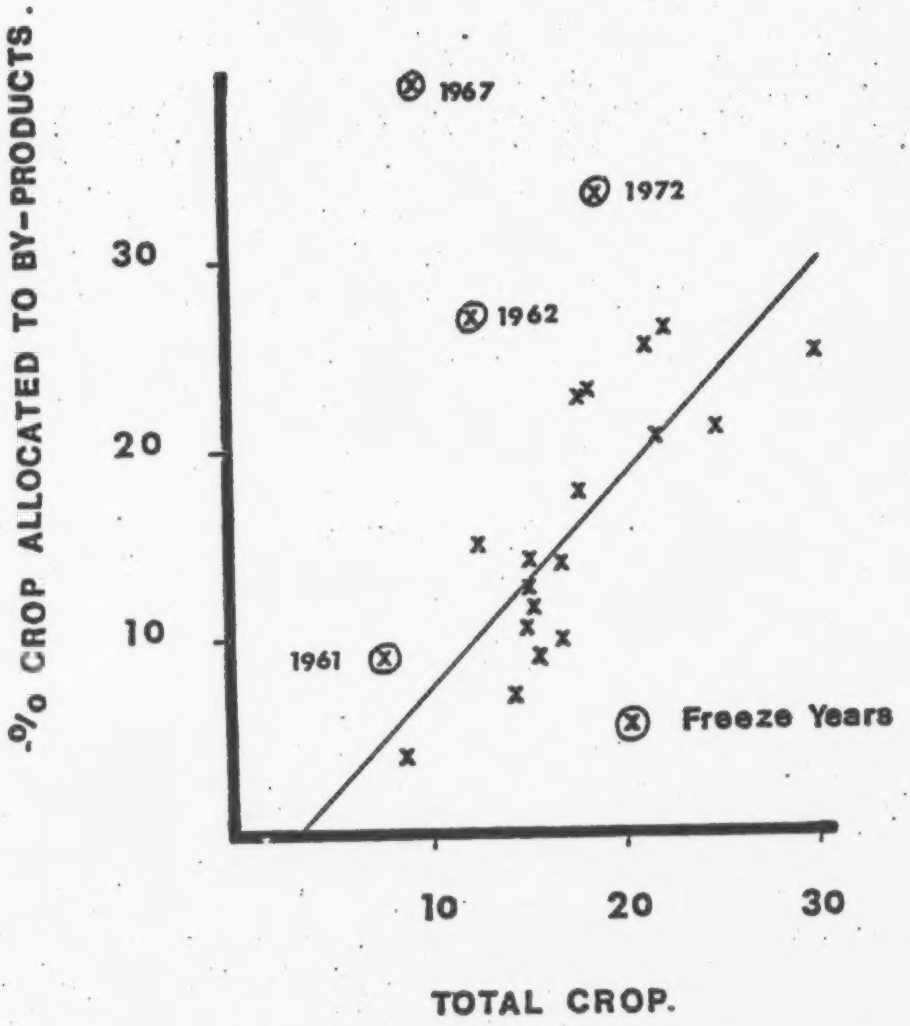
SEASON AVERAGE ON-TREE RETURNS PER FIELD BOX FOR CALIFORNIA ORANGES.



Note: solid lines are regression lines for the period: 1950-55, 1959-63, 1964-71.

Figure 4

CALIFORNIA NAVEL ORANGES.



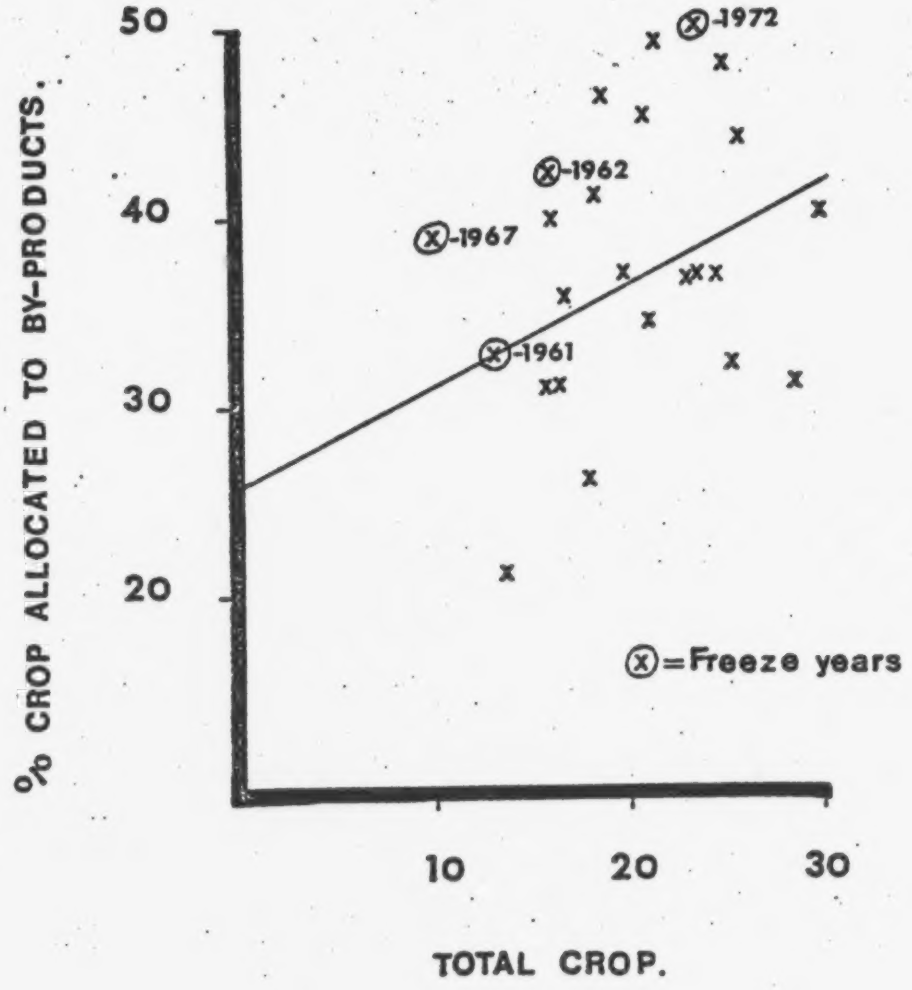
Slope = 1·1029

Hypothesis that slope = 0 is rejected at the 5% confidence level.

Freeze years eliminated from data.

Figure 5

CALIFORNIA VALENCIA ORANGES.



Slope=0·5602
Hypothesis that slope = 0
is rejected at the 5%
confidence level.
Freeze years eliminated
from data.

Figure 6

CALIFORNIA ORANGES 1973-74.

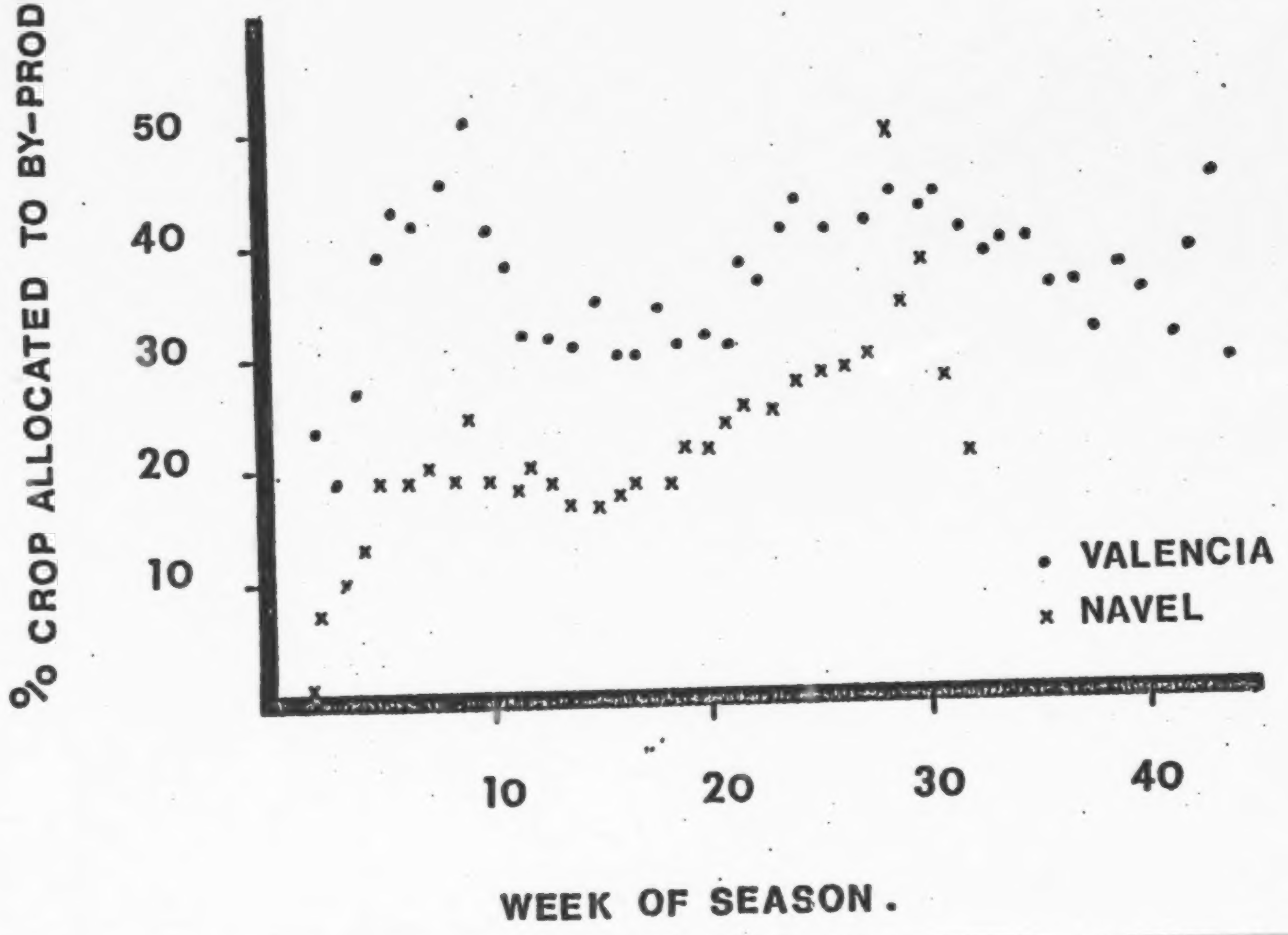
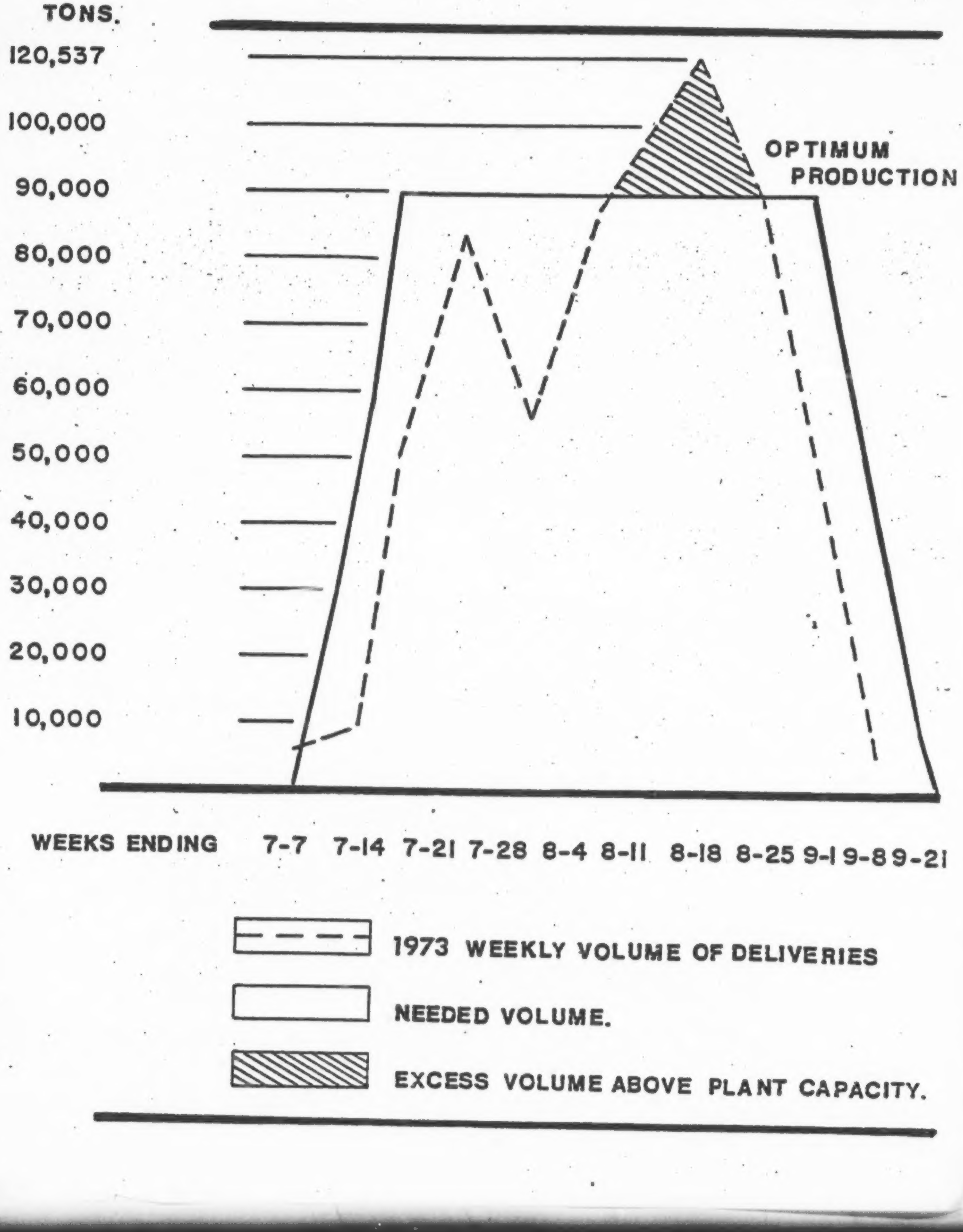


Figure 7


TONS.
120,537
100,000
90,000
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
OPTIMUM PRODUCTION
WEEKS ENDING
7-7
7-14
7-21
7-28
8-4
8-11
8-18
8-25
9-1
9-8
9-21
1973 WEEKLY VOLUME OF DELIVERIES
NEEDED VOLUME.
EXCESS VOLUME ABOVE PLANT CAPACITY.